THE

ELECTRICAL REVIEW.

VOL. XXXV. NOVEMBER 30, 1894. No. 888.

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ELECTRIC TRACTION.

THIS subject seems to be at the present time the most interesting one in electrical engineering, and many engineers are strenuously working for its adoption and success in this country. We sincerely hope their efforts will result in its extension to a very large degree.

A paper on this subject, by Mr. C. S. Du Riche Preller, M.A., read before the Institution of Electrical Engineers, which we reproduce elsewhere, gives us an idea as to the extent and usefulness of electrical traction methods, in Europe, for working steep grade or mountain railways.

First, in regard to cables worked by stationary motors, of which three examples are very briefly described. It will be noted that they are all worked by exceedingly cheap water-power, hence the economical working, but we cannot get water-power everywhere, and even in some cases where it exists, and could be used, the terms upon which it may be utilised are so exorbitant as to become prohibitive; for when the owner of a large waterfall learns that it can be employed to work a railway, he naturally begins to calculate upon its value to him, and looks upon it as a valuable property, and no longer as water running to waste.

The author of the paper, without the least attempt at an explanation of his meaning, states that the total efficiency of these cable traction electric railways is 60 per cent. Such a statement requires some explanation as to how it was arrived at. A single motor, a dynamo, or an engine, may be said to have an efficiency of 60 per cent., and we know exactly what is meant. But without the most precise information as to how the efficiency of a complex system is obtained, the simple figure stated is valueless.

We emphatically protest against this loose practice when reading papers before engineering societies, of putting forward figures which are only estimates, instead of actual ascertained results. If only estimates can be given, then we must insist upon having a clear statement of the methods upon which they have been based.

Whatever this 60 per cent. may mean, it cannot possibly mean the total efficiency as usually understood by that term; and as many discussions are about to take place on electric traction, it may be well once for all to define our ideas on total efficiencies, especially in regard to this particular topic.

An electric railway comprises many different machines for transforming and transmitting energy. A prime mover, a dynamo-electric machine, a system of insulated conductors, a moving electro-motor or stationary motor, regulating resistances, and gearing between the motor and the locomotive or car. These are the elements of an electric railway, and there are only two ways to arrive at the total efficiency of such a combination. First, we must measure or estimate the efficiency of each element separately, and add up all the

losses to get the total efficiency. Secondly, we must measure the total input of energy at the power house, and total output on the car or locomotive axle, an exceedingly difficult thing to do, and one which, we believe, has never been done in practice.

But we can approximately arrive at the total efficiency by calculating from the well-known efficiencies of the elements of the system, for although it is almost impossible to measure the total input and output, we can easily find many determinations of the efficiencies of the separate elements.

In these cases of water-power quoted, we cannot allow a higher efficiency for turbines than 80 per cent.—a very high estimate—then the gearing between the turbines and dynamos must account for at least 5 per cent.; the dynamos, if worked constantly at full load, would waste 10 per cent.; but on an electric railway as the load varies largely, there will be a further loss, about 15 per cent. or more. In the case of the Burgenstock line, after incurring losses in the power-house, the remaining energy has to be carried 2·5 miles to the motors. If the author of the paper had given the fall in pressure on the line, we could have found its efficiency; but it is safe to assume that another 5 per cent. would be lost on the way, and probably as much as 15 per cent. may be lost. What is now left of the power is delivered to the motor, which, running at varying speed and load, wastes from 10 to 30 per cent. again. The power is then passed on to the cars through gearing and cables, and these, judging from cable haulage experience, will take at least another 20 per cent. of the power; and what is now left is that actually usefully applied to the work, and we daresay if all these losses are added up, and deducted from the input, that the 60 per cent. efficiency is far too high an estimate of the actual total efficiency.

Throughout the paper total efficiencies are given as 58, 62, 65 and 68 per cent. for different railways, but we cannot accept any of them as correct, for with the plants described in the paper they are impossible figures. The number of transformations of energy, and the amount of gearing it has to pass through, not to speak of the losses in motors running at variable speeds, and regulated by resistances, would account for far more than a loss of 40 per cent.—70 per cent. would be nearer the mark. In a paper of this kind, where details accurately ascertained (such as pressures, currents, resistances, horse-powers, and curves of performances), are not given, the less said about efficiencies the better; without these the figures can be taken only as the result of guesswork. It is more important to learn from the paper that whatever the total efficiency may be, the lines described are all successful in every respect, for this proves that the advantages of electric traction, even at the present day, are great enough to counterbalance the losses, whatever they may be.

Belt driving is said to be preferable to direct driving for railway work, owing to the great fluctuations in power required. There is probably some truth in the argument, which amounts to saying that the belt introduces some elasticity between the engine and dynamo, which considerably softens the shocks occasioned by the sudden rises and falls in the load. But this is a question which experience alone can decide.

Accumulators or storage batteries are recommended as a remedy against the fluctuations in load, and the installation at Zurich is quoted as an example, but no facts or figures are given in support of the statements. The Isle of Man Tramway is quoted as another example of the use of accumulators, but the Isle of Man case is of no value yet as an example. It has not worked long enough, and no results have been published by which its success can be judged. There is nothing new in applying storage; every engineer ever since storage became possible has held storage to be of paramount importance in every installation, whether for light, power, or traction. But it is futile to talk of the advantages of storage while the means at our disposal for storage of electrical energy are so limited.

We do not think the alternate current motor is yet perfect enough for traction work, but there is little doubt that if the primary obstacles to electric traction in this country were once overcome so that the business could develop, suitable alternating current motors would be forthcoming.

Multiphase motors might at present be used, but the introduction of a third insulated conductor is both expensive and complicates the system of collection; they have, therefore, not been used except in an experimental way. If storage has any advantage in a traction system, it would be entirely lost in an alternating current plant, and no alternators yet designed could regulate quick enough to keep in step under the violent fluctuation in load. When we come to seriously consider the alternating current for traction, we find that there are disadvantages as well as the advantages mentioned by the author of the paper, and it is well to look at both sides of the question before agreeing with him that the alternate current is destined to supplant the continuous current in traction work. This is one of those questions upon which it is never safe to prophecy unless you know; it is very questionable whether alternating currents will supplant the continuous current even for lighting purposes. The trial is not at an end yet.

A WARNING TO LOCAL AUTHORITIES.

In recently visiting a number of electric light stations in this country, we have been painfully struck in many instances with the evident mark of the "cheap and nasty." This, no doubt, is the result of the very pernicious system, so greatly in vogue, of asking for tenders, and then, quite apart from any detailed considerations as to the merits of construction and design (which can never really be specified for) accepting the lowest tender.

Happily this state of affairs is being somewhat improved, and engineers are giving more careful consideration to these matters, and are more prone to accept what are, in reality, the cheapest goods to buy, though by no means the lowest in price according to tender.

Of course, there are some honourable exceptions in the work which has been done, but one repeatedly comes across work of a very inferior nature, both in design and construction. In no part of the electric light systems is this more apparent than in the switching apparatus of generating stations. At one station we saw a switchboard of which the only remaining parts of the original one were

the ampère and voltmeters (which were not made by the contractors who made the switchboard) and a few copper connections. The whole of the switching gear proper had been removed and replaced as being defective. It is needless to say that this was the result of accepting the lowest tender, and in the light of such experience, it is easy to see that the lowest tender was in all probability the dearest which could possibly have been taken.

At several other stations which we visited the switching gear was of the most trumpery nature, and it was evident in one particular case, where it had been made by people of very high standing, that the design had been got out with a view to producing the cheapest article, and not the best article which could be made, in order to give the particular contractor a better opportunity of getting his tender accepted for all the plant in the station.

What we have said with regard to the switching gear applies equally to almost everything else constituting the plant in an electric generating station; but we have simply taken this particular case as one which comes directly before the notice of anyone making an inspection of the stations.

It is easy for engineers to specify exactly what they want, but unless they can specify a particular design of apparatus, which can be seen fully carried out and at work already, they cannot go into sufficient detail to ensure everybody tendering for equally good and effective work, and it therefore cannot be too strongly urged upon those who have the question of deciding which tender should be accepted, the grave necessity of looking most searchingly into the quality, design, and permanent utility of the work which they are buying.

It may be taken for granted in many cases of this kind that the best work cannot be obtained for the lowest price, and that in the higher price given by some contractors a much higher quality of apparatus is included, and that the price does not stand above their competitors on account of the desire to make a larger profit.

It is often the last resort of manufacturers to give an extremely low price to sell their goods, which under ordinary circumstances would not receive consideration in comparison with other plant offered, but it is well to bear in mind that if the plant were good enough to sell at a fair price, people would not offer it at a ruinously low figure to get their machinery sold.

It is extremely difficult for a young borough engineer to stand up against a strong assertive committee, impose his opinions as to quality, and justify a tender from a reliable firm at a price well above the lowest. There are generally strong men on an Electric Lighting Committee—that is, assertive men, ready tongued, always having an answer. How can a young professional man, whose wits have not been sharpened in the market place, carry things in the best interest of the undertaking?

In conclusion, we would strongly urge upon local authorities and others going in for electric lighting work that the only advantage of competitive tendering is to ensure good makers not putting an unreasonable profit upon their work, and for this purpose the method now adopted is good; but it is evident that the system must end here, and that discrimination must then be brought to bear to select the best plant, which will undoubtedly prove the cheapest which can be bought.

The Alteration of Conductivity in Liquids by Pressure.

There is an interesting paper in the *Zeitschrift für Physikalische Chemie*, xiv., p. 433, by G. Tammann, whose researches we have frequently had occasion to notice. This paper appears to be strictly of a theoretical nature, but upon reading it, it turns out to be rather suggestive, and we think that the author has struck upon a line of investigation which may turn out to be very fruitful. Regarding the internal pressure of a solution to be given by the equation, $\pi = K + \Delta K + p$, where K is the internal pressure of the solvent at zero external pressure, and p is the external pressure, the author points out that the alteration of physical properties may be connected with that of the internal pressure by the equation, $\Delta E = f(\Delta K + p)$, and hence by the observation of the influence of external pressure on any property of a solution, the difference between the internal pressures of the solution and the solvent may be determined. Fink's experiments on the influence of pressure on electrical conductivity afford the necessary data, and from his results the values of ΔK for a number of liquids are determined and compared with those obtained by isobar diagrams. The concordance is not very good, but is sufficient to justify the reasoning, especially in view of the magnitude of the probable errors. Tammann gives the corrections of the conductivity for internal pressures, and concludes his paper with a short inquiry into the cause of the alteration in conductivity by pressure. It may be due, he thinks, to a change (1) in the number of free ions, and (2) in the internal friction between the ions and the molecules of the solvent and dissolved substance. The second of these he considers to be the chief cause, for Röntgen's experiments show that in the case of water, a pressure of 500 atmospheres has very little influence on the number of free ions. Rontgen's conclusions, however, are the reverse of these, and are not, in Tammann's opinion, justified by his experimental results. In the case of water, unlike that of other liquids, the friction diminishes with increased pressure, and hence the conductivity increases, whilst the reverse must obtain with other liquids.

Colour-Making by Electrolysis

The principle of electrolysis is finding commercial application in directions which were scarcely dreamed of. Already many efficient processes for manufacturing chemicals are in active operation; one of the latest of these consists in producing Prussian blue and Berlin green. Prussian blue, otherwise known as Paris blue or Berlin blue and Berlin green are well known and widely used pigments, and with the competition set up now that it is possible to make them electrolytically, these useful colours should become much cheaper. The process by which they are made, and which is due to H. Goebel, consists in precipitating a solution of yellow prussiate of potash by means of a ferrous salt, such as green vitriol, suspending this precipitate in water, and then subjecting it to electrolysis. It is stated that Prussian blue of an extremely vivid violet "reflex" and coppery lustre is obtained. Sulphuric, hydrochloric, nitric, or phosphoric acids may be added to the electrolyte, so that it may contain 1—20 per cent. of acid. The precipitate is introduced in the immediate neighbourhood of the anode, the contents of the anode compartment being kept well stirred, as well as those of the cathode compartment. The hydrogen liberated is taken up by manganese peroxide or by organic nitro-compounds. When the electrolytic action is protracted, the blue colour becomes more and more faint and ultimately changes to a dark Berlin green.

The City Accident.

The Board of Trade enquiry into the City accident concluded last Friday, a report of the final evidence appearing in another part of this issue. Before we make any full comments on the circumstances which gave rise to the lamentable accident, we shall await Major Cardew's report. There can be no question, however, that the enquiry threw a strong light on many weak points in the administration of the City Company's affairs. For that reason alone the enquiry may result in something useful. We are sure of one thing, that is, no one more regrets the accident than the City Company themselves. They have encountered extraordinary difficulties, but their responsibilities are great.

THE BEST METHOD OF TREATING ACCIDENTS.*

By P. M. DYER.

It is my purpose to explain to you in what manner the North and West Chicago Street Railway Companies attend to personal injury cases, commencing with the accident and following the theme to the final disposition of the claim. These two corporations carried 167,000,000 passengers during the year ending December 31st, 1893, and upon the claim department devolves the duty of investigating all accidents and the making of settlements, or preparation of the defence, in all claims that spring from this great traffic. One claim department does this work for both roads.

The working force consists of a medical staff and a sufficient number of investigators, all under the direction of the chief adjuster, who reports to the general counsel of the two companies. For the purpose of this article, the work of the claim department may be divided into three periods, each separate and distinct from the others, as follows :—First, investigation ; second, negotiation ; third, litigation.

First, as to investigation. The work of this period begins immediately after the accident, and continues until there has been secured a full and accurate account of the accident, with reliable information as to the nature and extent of the injuries to person. *Employés* have been instructed to notify the claim department of the occurrence of an accident on car or train, giving circumstances of the same, nature of injuries to and residence of the injured, and, as far as possible, to secure the names of the witnesses. When this has been accomplished, and the injured one has been placed in the charge of a physician or the police, the car or train may continue its journey. In the meantime, a representative of the claim department will proceed with all possible despatch to the scene of the accident. If the injured person has not yet been removed, he must see that conveyance is provided to the hospital or to the home.

These companies usually bear the expense of temporary medical care and transportation, without regard to liability, believing such attention is appreciated by the injured and the community at large. In all cases of personal injuries, it is the duty of the medical staff to secure the privilege of an examination; the physician making the same to avoid any assumption of responsibility for the treatment, but to fully ascertain the nature and extent of the injuries, and to obtain, if possible, a concurrence in his report by the attending physician.

All *employés* witnessing accidents are required to make written statements of the circumstances of the same on printed forms provided for that purpose, attaching the names and places of residence of all witnesses. This report must be completed, and given to the foreman before the *employé* finishes his day's duties. These reports are forwarded to the claim department without delay, and when received, circular letters containing printed interrogatories are sent to each witness. If the seriousness of the accident demands it, interviews are had with the witnesses. That the claim department may be kept fully advised from time to time as to the condition of persons injured on these roads, they are occasionally visited during the period of recovery by the investigators assigned to those cases. In Chicago all hearings before the coroner are had immediately after the accident, and the verdict of the coroner's jury is usually rendered on the day following the death. It is the policy of these companies to secure the presence of their witnesses at the hearing before the coroner, and obtain stenographic minutes of the proceedings. Thus, in a comparatively short time, the claim department will have collected much information as to the condition of the injured, and the circumstances of the accident. We may now consider the work of the first period completed.

The reports relating to an accident could now be filed away, perhaps for ever, if it were not for the industry of some claim lawyer or other hustler, who persuades the injured to make a demand on the company for compensation. The making of a claim leads us to a consideration of the second period, that of negotiation. Demand being made for compensation, it becomes the duty of the chief adjuster to place before the general manager, or general counsel, all facts within his knowledge bearing on the claim, for a decision as to liability, and the naming of the maximum sum to be paid, if a settlement is deemed advisable, the claimant being promptly informed of the decision. As to the negotiations preceding a settlement, I need say but little. They are usually conducted by the chief adjuster on the part of the company. If not successful the period of negotiation will end, usually to be followed by litigation, the third and last.

After the commencement of suit all witnesses are again located by the claim department, and thereafter located at stated intervals until the time of the trial, and if possible additional witnesses are found to strengthen the defence. Success in defending suits arising from personal injuries largely depends on the character of the work done during the period of investigation. The officers of these companies believe in the thorough investigation of all accidents, if possible the settlement on a reasonable basis of all valid claims, in vigorously contesting fraudulent demands, and that prompt settlements are for the best interests of their companies.

In conclusion, I will say that the time is at hand when all railroad corporations must be prepared to resist claims in a large percentage of their accidents. To promptly prepare to do this is the part of wisdom, when considered from a financial standpoint, usually the determining consideration in corporate management.

* A paper, slightly condensed, presented at the Atlanta meeting of the American Street Railway Association. From the New York *Electrical World*.

4,500 VOLTS SHOCK NOT FATAL.

Our New York namesake published the following in its last issue :—

M. D'Arsonval, of Paris, when he reads this issue of the *Electrical Review*, can congratulate himself that his researches on the effects of electric shocks on human beings have resulted in the saving of another life. Owing to the methods of resuscitation proposed by D'Arsonval and their prompt application by the officers of the Stanley Electric Manufacturing Company, of Pittsfield, Mass., Mr. J. E. Cutler is alive to-day.

On October 23rd, the *Electrical Review* received the following press dispatch, which was sent out from Pittsfield, Mass. :

J. E. Cutler, superintendent of the testing department of the Stanley Electric Manufacturing Company, accidentally took hold of a wire carrying 4,000 volts this morning and suffered a terrible shock. Prompt attendance restored him to consciousness, and hopes are entertained of his recovery.

An inquiry for the verification of the dispatch and a request for further particulars was at once sent to Mr. Henry Hine, general manager of the Stanley Company. The following is Mr. Hine's reply :

To the Editor of the *Electrical Review* :

We are in receipt of your favour enclosing the enclosed clipping. In regard to this matter we would say that on October 22nd our Mr. J. E. Cutler received a shock from a wire carrying 4,500 volts. This pressure is used in our testing department for experimental purposes, and through an accident Mr. Cutler took hold of the two terminals carrying this pressure. He was immediately completely prostrated and to all intents and purposes was dead, but was revived by the method advocated recently in electrical and other journals by D'Arsonval, of Paris, that is, he was treated exactly as a drowning man would be, and a few minutes of this treatment finally brought him to. He was, of course, prostrated for a time by this accident, but the next day was again attending to his duties as far as his hands would allow him. His hands were quite severely burned by this shock and it will probably be some time before he obtains complete use of them. There is no doubt in our minds but that Mr. Cutler would not have survived this accident had he not been promptly attended to, and this experience should be of value to those who are liable to come in contact with wires carrying high pressures.

Yours truly,

Henry Hine,
Stanley Electric Manufacturing Company.

November 2nd, 1894.

THE ELECTRICAL INDUSTRY IN FRANCE.

Our contemporary, *L'Industrie Electrique*, recently reviewed the conditions under which the electrical industry is now being carried on in France and abroad, and appears to take a gloomy view of French undertakings as compared with those of other countries. Taking 16 stations, a brief description of each is given with special reference to the duration of the concession, the municipal taxation, price of coal, and cost of current per hecto-watt hour, which, of course, is the same in centimes as if stated in pence per kilowatt hour. We reproduce the table, as it contains several striking figures. Half of the towns given are English, and it is remarkable that in four of them the cost of fuel should be so high as compared with all the foreign towns excepting Milan. At the same time the Milan undertaking, with coal at 33·67 f. per ton, returns 10 per cent. of a dividend. True its price is high, nearly tenpence per kw. hour; but at Dusseldorf, where the price is tenpence and coal only a third the price it is at Milan, there is no dividend at all, nor is there at Breslau where conditions are about the same. No information appears which explains why this is so, but one must, of course, not judge from the apparently high price that this really seems high to people who have, perhaps, been paying dearly for gas. Again, in Geneva, where water-power is utilised, a price of sixpence admits of no dividend.

The Manchester undertaking is too recent for any dividend to have been declared, but it is given as an example of a recent undertaking carried out with the full benefit of all previously acquired experience, and showing the amount of capital necessary for such enterprises at the outset, namely, £129,300 for 28,000 lamps, which may be compared with the Westminster Company's £381,000 for 76,700 lamps. Attention is drawn to the fact that with all the perfections of the Manchester station that have been brought about by experience, the cost of producing electric energy is almost the same as at other stations where coal and labour are also equal.

City.	Population.	Equivalent No. of 16 C.P. lamps, or	Years of concession.	Municipal tax, per cent.	Price per kilowatt hour.	Price of fuel per ton. Shillings	Last dividend per cent.
Vienna ...	1,400,000	25,000	50	3	9d.	16/8	2
Dusseldorf ...	193,000	18,300	perpetual	0	10d.	9/2	0
Breslau ...	354,350	15,118	„	0	9d.	8/11	0
Berlin ...	1,710,000	194,000	30	10	vari'ble	17/11	10½
Liverpool ..	600,000	29,000	42	0	7½d.	8/4	5
Manchester	515,598	28,000	perpetual	0	8d.	8/4	?
Glasgow ...	750,000	26,550	„	0	6d.	8/8	3½
Birmingham	500,000	12,000	42	0	7d.	8/8	4
Westminster	?	76,700	42	0	6d.	19/8	4
Oxford ...	50,000	5,500	perpetual	4½?	7½d.	21/9	0
St. James's	241,993	99,000	42	0	5½d.	20/3	4½
House-to-House ...	?	20,326	40	0	7 4/10 d.	20/-	0
Milan ...	433,324	34,821 / 957 arcs	perpetual	0	9 54/100 d.	28/6	10
Geneva ..	72,000	15,000	8	0	6d.	water	0
Lausanne ...	33,000	900	perpetual	0	18d.	...	0
Copenhagen	326,000	25,800	„	0	8½d.	11/2	0

Of the 16 undertakings in the table, eight only have been able to return a dividend on their last working period, and a general review of these large concerns shows at a glance that the electrical industry is not very prosperous, even outside France. This, too, despite the advantage of large capital and newness of construction, excepting only the Société Suisse, which is the oldest in Europe. All of them, too, except the one at Milan, have longer working hours than is the case in France—that is the duration of the load period is greater. Foreign enterprises, also, are seen to be more favoured in respect of fuel cost, seeing that the price varies from 11 to 24·35 fr. per ton as against 32 fr. in Paris. But there is another cause, viz., the duration of the concession, which is, at least, 42 years, and in many cases perpetual, while in France it is much less; in Paris only 18 years' concession is given. Foreign municipalities, also, do not take a tax on the receipts, whereas this is the rule in France, and amounts, in Paris, to no less than 5 per cent. of the gross receipts, in addition to certain controlling costs and a rental charge of 100 francs per kilometre of line. Even without taking account of the difference in fuel cost for the Parisian companies, the inequality of the duration of the concession has an enormous effect, as it is easy to show, for it is necessary to levy an annual charge on income (when, adds our contemporary, there is one) sufficient to return to shareholders their capital at the end of the concession period. Had the original capital been unchangeable and sufficient to carry through the period of concession it would have been simply necessary to pay off a fixed sum annually, but, instead, the companies have called new capital to satisfy the wants of their new subscribers. The amortisation of capital calls for an annual charge almost in inverse ratio to the duration of the time over which the payments are spread. Thus, at 5 per cent. interest and a period of 18 years, £1 will demand an annual charge of 1·711 shillings, while with a 9 years' period the charge becomes 2·814 shillings. Thus it is that French enterprises are placed in a position of inferiority that cannot be gainsaid, and this is the more to be regretted in that if three of the Parisian companies have paid a poor dividend by charging for current a price too high for the bulk of consumers, the other two are working at a loss.

The clauses of the agreement of 1888 were fixed by the Municipal Council in the belief that electricity had a grand future, and would overturn everything; but they were mistaken, for electricity has superseded but little, simply because of the high price of current, and affairs will remain so till such time as more perfect means of utilisation and transmitting current admit of better returns. It is, therefore, necessary that, as a young industry, electricity should be assisted and untaxed, and those who have been instrumental as pioneers might then hope to draw some little revenue from their hitherto unproductive property, which is designated by *L'Industrie Electrique* as a mine of metallic copper under the streets of the great cities of Europe.

If there is anything to be learned from the table, it is that selling price and fuel cost are by no means the chief factors in the equation determining the figures in the final column.

It would appear that French electrical enterprises are now suffering from the extravagant claims once put forward for electric lighting, the result having been that only short concessions, saddled with onerous charges, have been granted to the companies, and practical working has demonstrated the impossibility of profitably working under such heavy loads. Comparing, however, Manchester and Oxford, our contemporary has evidently secured incorrect figures, Oxford with its 5,500 equivalents of light, the cost of installation and mains being given as £116,600, as against a cost in Manchester of £129,300 for 28,000 equivalents.

FORCED v. NATURAL (P) DRAUGHT.*

By PETER H. BULLOCK.

Of all the separate things that relate to the erection and economical management of steam plants, perhaps there are none about which there is so wide a difference of opinion as on the subject of draught for producing the satisfactory combustion of fuel.

Mr. Le Van goes on record as thinking forced draught a mistake, and argues in favour of chimneys of sufficient height and area to produce the requisite draught for boilers. All cases and problems, however, have more than one side to be looked into, and like mountains they very often look different when viewed from different standpoints. If conditions were always the same as to surroundings, quality, and price of fuel, permanency of location and amount of capital

* New York *Machinery*.

available to invest in a manufacturing establishment, it would be quite easy to scientifically determine which method it would be best to adopt in order to successfully do very many of the things about which we are often in doubt, and about which the best informed men disagree.

Regarding the subject from a sanitary point of view, there can be but one opinion as to the desirability of delivering the gaseous products of combustion at as high an altitude as possible, so that they may become rarefied to such an extent as to be harmless and unnoticeable to any who may live or work in the vicinity. Besides, it is not to be supposed that any one who might equip a boiler plant with any kind of forced draught would be inclined or allowed to construct it in such a way that its operation would be injurious to the health of operatives or inhabitants.

As to the claim that there is always an upward draught in chimneys regardless of the presence of heat, I am not willing to admit, although in a majority of cases it is so, especially if there is any wind blowing, and most persons know there is very seldom a time when there is not some movement of the air. Of course the draught induced by the action of the wind is as well understood as is that produced by the ascension of the column of heated gas and unfiltered air that make up the volume of a chimney when carrying away the products of combustion from the furnaces of a boiler plant. Given, for instance, a chimney of any reasonable height, and in which there is absolutely no heat, and a day when there is absolutely no wind, and it will be found impossible to detect any ascending current in the flue. Were it otherwise, a service of perpetual motion would be at our disposal. On the contrary, if the chimney base happens to be in a building considerably sheltered, and the temperature happens to be lower than outside, there may be found a descending current into the cooler space below.

One of the advantages of forced draught is the fact that it can be run to exactly suit permanent conditions of location and the variable demand for steam regardless of the conditions of wind or weather. This flexibility of draught makes it possible for the intelligent engineer to find out, by comparison, what rate of combustion is the most economical for his particular plant, and what quality of coal the best to use. It permits him to control the vital principle of combustion and to take advantage of all the information he thus requires. Where the draught is produced by a chimney, its maximum capacity is a fixed factor dependent upon its height, area, and temperature, but modified by the velocity of the wind at all times, and occasionally by its direction, as when other structures induce deflecting currents either at its top or base.

Forced, as artificial draught is usually interpreted, means that produced by any other means except a chimney; but to be accurate, a chimney is as much a means of artificial draught as any other method, and often more costly to operate than many others. With this absence of distinction in principle fully in view, it is then in order for anyone who proposes to erect a steam plant to choose any of the methods that are available, keeping in mind the first cost, cost of maintenance, and probable economy of operation.

Regarding the different means of producing draught other than by area and elevation of stack, the one most usually adopted for stationary purposes is either by forcing air through the fire by a closed ashpit, or by exhausting the gaseous products of combustion from the up-take after they have passed the heating surface of the boiler. In either method the results are substantially the same, so far as the temperature of the escaping gases are concerned, for in the first case they are forced forward by continual displacement as more air is forced through the fire, and in the other they are sucked away, and the space filled by air that forces itself through the fire to replace that exhausted, the comparative temperature at the up-take being of little consequence in either case, so far as the movement of the volume is concerned. And right here is where the forced draught may get in its economical work, from the fact that the heat should be absorbed by the boiler or economiser nearly to the temperature due to the steam pressure carried, or far below it if an economiser is used; while in the case of a chimney the temperature must be high enough to produce the necessary draught, or usually about 600°. Now if the heat between these limits is turned into energy, and that energy is more than sufficient to mechanically produce the necessary draught, the difference must represent the economy of the operation, as the saving in using a forced over a so-called natural draught or chimney.

Much has been written regarding the loss due to leaks through cracks in the brickwork and connections of boilers, and also through the porosity of the brickwork itself. That such leaks do exist cannot be denied, but the amount due to porosity or to air going directly through the bricks and mortar, can be put down as a very small per cent., owing to the small difference in pressure between the flue and the outside, but cracks in brickwork and around flue connections are pretty sure to be in evidence, and are a direct loss in every case. The different methods of forced draught will also affect these leaks differently, as for instance, if the air is forced under the grates, the leakage may be from the furnace and connections outward, and besides the loss of heat the gases may be unpleasant, as well as injurious to health. If the draught is produced by suction in the up-take, the result is the same as in the case of a chimney.

There are several little things to be thought of, and which have their bearings both for and against forced draught, not only in the first construction, but in the subsequent operation of them. I will note a few: Regarding a chimney, it may be said that its cost and capacity can be very accurately figured, and that when once properly erected there need be no further thought given it, except to charge interest on its first cost. Its cost of operation, however, as before noted, may be quite a figure. Where mechanical draught is wholly depended upon the plant is comparatively helpless until there is sufficient steam to set the apparatus in motion. Where air is forced under the grates it is usually necessary to close off the supply when the furnace doors are opened. There will also be more soot and fine ashes deposited in the tubes and connections than when the gases are exhausted. Of the two systems, it is my opinion that unless some peculiar conditions exist, that exhausting is the preferable one to adopt.

The writer's first experience with the subject was the burning of tan-bark screenings and soft coal, using a blower to force air under the grates; and next after that, and now more than 20 years ago, was with an apparatus fitted up to exploit a boiler designed by a man who thought himself an inventor, and who was about to revolutionise mechanical matters in general. The boiler was a failure, but the means for exhausting the gases worked to perfection, and was substantially the same method as now generally adopted for the same purpose. The fan was run by a small engine arranged to run at any speed necessary to meet the varying conditions, but in a properly designed plant the speed of the fan should be governed by the steam pressure acting through suitable attachments to a sensitive damper regulating machine.

Chimneys will never be replaced by other methods, but the use of mechanical draught is bound to increase as its advantages become better known.

THE COMPETITION OF WELSBACH BURNERS WITH ELECTRICITY.

In the New York *Electrical Engineer* of October 31st, the subject of the competition between the electric light and the Welsbach incandescent gas burners was discussed editorially. Since that time our contemporary has been in receipt of a number of interesting communications on the subject from central station managers, who have given the matter attention, or who have had to experience more or less active competition. Some of these remarks are appended :—

In common with many others, we are having an experience with the Welsbach burner. I must confess that with the introduction of this burner in its present shape, I felt somewhat annoyed. When new, the brilliant white cone of the Welsbach burner certainly appeals to the eye of the public. One of our customers (a druggist), lured by its brilliancy, and fortifying himself with the statement that the excessive heat evolved would help him out with his heating this winter, equipped his store about a month ago. He now mourns the $2 invested in each burner. From the brilliant white of a

few days' duration, the light dwindles to a ghastly, greenish, billious gleam. The druggist, with several others who have paid for their experience in the shape of first installation, hood and chimney renewals, and an unsatisfactory light, is now ready to treat with us for the return to incandescent lighting. Let anyone stand 30 or 50 feet away from two stores (side by side), No. 1 illuminated with Welsbach burners which have been in service two weeks, and No. 2 lighted with an equivalent of incandescent lamps. The Welsbach immediately attracts his attention. He sees comparatively large burners emitting a ghastly, greenish-white light. Objects within the store are shrouded in gloom, and are seen indistinctly. No. 2 apparently exists in a clear, cool atmosphere, every object within being clearly seen. The above facts, coupled with those given in the columns of the *Electrical Engineer*, of October 31st, and an effort on the part of electric light people to keep up their lamps to the highest possible standard, should in a short time set aside the Welsbach as a rival.

Since the conversation I had with you the other day on the subject, I have been looking around town to ascertain the number of Welsbach burners that are being put in. I told you that there were about 125. That was the count up to that time, but at present I think there must be in the neighbourhood of 750. Yesterday we had four customers leave—two arc and two incandescent—and they have filled their stores with these burners. It is done mainly on account of the cheapness that presents itself. They are being introduced here at a cost of $2.50 per burner, with the guarantee of keeping them in order for six months, which, I presume, means the renewal of the mantles. I find quite a number of them going in where only two or three are used in a place, superseding the old method of burning gas, and, in some instances, the incandescent light. I do not think the question which you raise in your editorial as to the noxious influence is going to weigh very heavily or will be appreciated by the consumer. From experience I find that patrons are willing to accept the baneful condition of the atmosphere as against the saving that will come to them. When I presented it yesterday to a man and gave him in a general way the injurious effects, and stated my own experience in the use of them in my house some years ago by the use of natural gas, I was met with the reply that it made no difference how bad the atmosphere was, they could open the doors and let in fresh air as they wanted to. They were after a cheap light, and believed they had got a better light than incandescent light at quarter the cost. Here, where we have natural gas, it is connected on to the main service lines of a house on the basis of 25 cents a thousand cubic feet. This, you see, makes the lighting per month for practically nothing. The illuminating gas companies, as well as the fuel gas companies, are not favouring this burner, but they are powerless to prohibit anything that customers may put upon their burners. Experiments at the gas company showed that these burners consumed less than one-half what a five-foot burner would.

I do not look with very much concern upon it. It is one of the things that come to us periodically, and here I am quite sure that it will not prevail, as it is being discountenanced by those that it would look to for the most encouragement, the gas companies. I may note the statement of a well-known expert that when an increased pressure is put upon the lines incident to the holiday trade, the filaments will be consumed. From actual experience I know that the ageing of them is very rapid. All these arguments and statements go for naught with the people we have here, who lie awake nights finding a way to get something for nothing.

The portion of your editorial which referred to the good policy in efficiency of lamps is timely. It is a matter that we have looked after carefully, and, I think, intelligently. We found that the plan adopted by very many electric light stations was to consent to, if not encourage, people to buy lamps wherever they could. This resulted with us in finding installed all kinds of lamps without regard to voltage, and a constant complaint upon the part of our customers that our current was no good. We have adopted the plan of selling lamps to our patrons at 20 cents each. This has righted the abuse.

We have a man who is looking after the Welsbach matter, and from time to time I will let you know to what extent they are adding the burners. The Welsbach people have recently opened a store, and are canvassing the city, more particularly the business portions of the town, and from present indications, I think that they are doing a good business.

When I was in New Orleans the Welsbach burner was making some headway, the first month of its use. A number of the clubs in the city adopted its use to the exclusion of electricity. The renewals of the prepared cone are a great drawback, as each renewal means 50 cents to the consumer. In the cities where the people have to buy the renewal lamps for 50 cents, they do not mind paying for the prepared cone renewals at that price, for the consumption of gas is reduced and they get a better illumination at a less expenditure of money for gas. In cities where the electric company furnishes renewals, it will not make so much difference, as customers would rather pay a little more for light than pay for the renewals of the Welsbach. The life of these cones is only 700 hours.

I have read your article of October 31st in regard to the Welsbach burners. There are something over 2,000 of them in use here. We do not fear them, and I cannot see that it has made any difference in the use of incandescent lights. I agree with your article in regard to the use of incandescent lamps. When they are discoloured, I believe in taking them out and in keeping our customers satisfied.

In regard to the Welsbach burner, I would say that it has not as yet assumed such proportion that we consider it a competitor in our business. Of my own knowledge, and from all the information that I have been able to obtain in the matter, we have lost very few, if even a single customer on account of it.

We have a few Welsbach burners in use here, but they have not injured us thus far, and they do not seem to increase rapidly. We note that the light is very white when the burner is new, but after a couple of months it assumes a weird, greenish glare, better calculated for a spectacular drama than for the prosaic illumination of everyday life. We use high efficiency lamps and replace them when they become blackened.

THE G. E. MAGNETIC BLOW-OUT FUSE CARRIER.

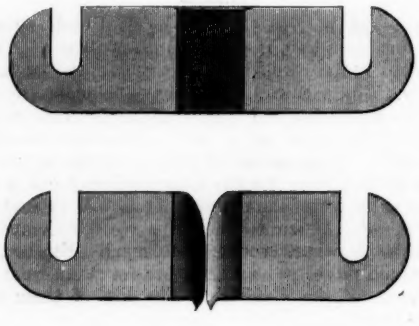
An interesting experiment was recently made at the Kent Avenue Station of the Brooklyn City Railroad Company, to test the efficacy of the magnetic blow-out principle in the fuse carriers which form part of the General Electric Company's generator equipment. Previous to the test there had been, on the part of the railroad company, no little scepticism as to the value of the magnetic blow-out principle, and the test was made with the view primarily of proving the correctness of the claims of the manufacturing company that the apparatus would cope with almost any demand made upon it.

According to the New York *Electrical Engineer* the test was made on the company's dock behind the station under the supervision of Mr. Walter A. Pearson, superintendent of the station. Six water rheostats of large capacity were connected in the circuit in series, in order to regulate the load, and the conductors were brought directly from two of the four 1,500 kw. multipolar generators. The fuse blew at 4,400 ampères at 550 volts, equivalent to 3,243 H.P. The result of the test was a complete demonstration of the efficacy of the magnetic blow-out on a very powerful and destructive arc. The engraving shows the blown fuse and one of similar capacity intact. It will be seen that the action of the magnetic blow-out must have been instantaneous, and perhaps the most remarkable feature is the small amount of metal blown.

The magnetic blow-out principle is a special characteristic of all apparatus manufactured by the General Electric Company which has to deal with possible arcs. It is successfully

embodied in the well known "K" car controller, as well as in the lighting arresters, fuse-boxes, &c.

The fuse-box in which the fuse shown was blown



was exhibited at the Atlanta Convention and served to convince many who had doubted the efficacy of the magnetic blow-out principle.

CATHODE RAYS.

By E. E. BROOKS.

In a recent number of this Journal there was an interesting account of Dr. Phillip Lenard's recent investigations on cathode rays, and the writer seems to agree with Poincaré in thinking that the results obtained are not in accordance with Crookes's theory or with the kinetic theory of gases, and tend to show that the cathode stream is directly due to the luminiferous ether.

It is not likely that these views will be generally accepted. No doubt Mr. Crookes will have something to say about them in good time, and meanwhile it may be worth while to examine the facts upon which these somewhat premature conclusions are based. These are in themselves of great interest, and form a valuable addition to our knowledge. We learn that the cathode stream can penetrate thin metallic films impervious to the remainder of the gaseous medium, and may then be examined outside the vacuum in which it originated. It is then found that phosphorescence effects are produced in gases at atmospheric pressure close to the metallic film, which, in the case of air, can be detected through a maximum distance of 2·35 centimetres, or about 1 inch, while in hydrogen this distance increases to 8 inches. At ordinary pressures the obstructive effect of different gases is proportional to their densities, while at low pressures it is approximately the same for all substances. We are also told that the properties of the cathode stream depends upon the pressure at which it is produced, and that the magnetic deflection due to a given field is the same for all gases and under all pressures, providing the pressure at production is unaltered.

Leaving the new results for a moment, let us first inquire how the older facts can be accounted for on the hypothesis that the cathode stream is due to the ether, and independent of ordinary matter. As regards phosphorescence, one theory is perhaps as good as the other, because we don't know enough of its nature and method of excitation to theorise much about it; but in considering mechanical motions and heat, we are on more familiar ground.

The nature of the etherial action is not stated, but apparently we have either to deal with a bodily transference of the ether, or wave motions in it. The former view seems out of the question, and if the idea is entertained, we have to admit that the impact of the ether stream on thin solid surfaces may create a pressure equivalent to a force of, at least, 100 dynes per square centimetre (according to Lord Kelvin), with corresponding production of heat when the pressure is resisted. Our ordinary ideas would have led us to expect that the etherial stream would blow through the solid absolutely without resistance. The wave motion idea possesses similar difficulties, and is equally opposed to our conceptions of the ether, unless the waves are very different to those which we are acquainted with.

There is no evidence to show that the impact of ether waves on a solid surface can set up such mechanical pressures. In the radiometer it is usually regarded as a secondary result, due to rise of temperature. We might possibly admit some slight friction between matter and ether, such as Balfour Stewart and others have looked for experimentally; but when we get such powerful effects as those produced by the cathode stream, we are obliged to conclude we are dealing with ordinary matter, until that view is clearly shown to be untenable.

It is evident, therefore, whatever we may find to be the case with the new results, the etherial theory is difficult to deal with in connection with the older ones.

But are the new results really opposed to the molecular theory? Stated concisely, this assumes the cathode stream to consist of material particles—the residual gas molecules, which are driven from the cathode in paths everywhere normal to its surface, penetrating down or through the tube to an extent depending upon the opposition met with, and in a sufficiently good vacuum moving with probably accelerated velocity until stopped by the walls of the tube or some solid substance within it, while the amount of divergence from a strictly rectilinear path will depend upon the self-repulsion due to their negative charges, and the extent to which collisions occur. If this is admitted, the mechanical and heat effects follow at once. Let us now examine Lenard's results from this point of view.

He finds that the cathode stream can pass through very thin partitions of gold, copper, or aluminium. This means that when the stream of gaseous particles impinges directly upon the partition, some of them pass through it. There seems to be no particular difficulty in admitting the possibility of this. A partition, gas-tight to particles in ordinary diffusive motion, is not necessarily gas-tight when the particles impinge directly upon it with much greater velocity. It is an interesting result, but not opposed to previous knowledge. For instance, rise of temperature will determine the diffusion of hydrogen through a comparatively thick platinum tube; Spcttiswoode found years ago that gas in a vacuum tube is, under certain conditions, absorbed by or expelled from metallic electrodes, according to the direction of discharge; while all experimenters have experienced the difficulty of getting rid of gases occluded by terminals. It is true none of these examples are exactly comparable with the present effect, but they indicate that there is nothing unreasonable in supposing that a metallic film $\frac{1}{8000}$th inch thick may be somewhat permeable to the cathode stream while practically gas-tight to molecular diffusion, or, at any rate, only permitting those particles to pass through it which happen to possess a more than average velocity in the right direction. (Goldstein's work on the behaviour of perforated non-metallic substances as cathodes may also be referred to as bearing upon the question.)

We have then a jet of particles projected through the metallic film into the external air; it may be with velocities somewhat diminished in transit, but still much greater than the inter-molecular velocities of the air particles. What should we naturally expect to be the result? Imagine an electrified jet of ordinary air issuing from a small aperture. Its influence can be felt through a certain distance, but it gradually becomes broken up and diffused by collisions and by self-repulsions.

The actual number of particles in the emerging cathode stream is almost infinitely fewer than in our imaginary air jet; while, on the other hand, their velocity probably enormously exceeds that of the fiercest hurricane. Still, we should naturally expect the same general result to follow. Close to the film we might expect to obtain weak phosphorescent effects, which would gradually decrease with the distance until too faint to be detected; not necessarily because all the particles get stopped, say, within 1 inch, but because their directions have been altered by repeated collisions, until the number striking the test object becomes too few to produce a visible effect. It is also clear that if the pressure of the external medium be reduced, the jet will be perceptible at greater distances. Further, bearing in mind Avrogadro's law, it is not surprising to find that the amount of deflection produced by different gases varies with their densities, and it might also be predicted that in a good vacuum the length of

path would be about the same for all media, as the collisions would then be, in great measure, eliminated.

All this is strictly in accordance with Lenard's results. He also states, as a remarkable fact, that if the external space be an absolute vacuum the rays can still propagate themselves, and, apparently, considers this to be totally at variance with the older theory. We may remark, in passing, that Lenard's best vacuum still contains 10^{10} molecules per cubic centimetre; but assuming it perfect, as a matter of fact, it is exactly what the older theory would lead us to expect. If you can only get your gas particles in motion in a perfect vacuum they will continue to travel all right afterwards, and the reason why a tube finally refuses to conduct is because you can't start the particles, perhaps on account of the excessive resistance at the cathode surface. But if you start them at a lower exhaustion, and then let them pass into the better vacuum, there is no reason whatever why they should not continue in motion.

We also find it stated that Hertz was the first to observe that cathode streams of different kinds exist, which differ in their capacity for phosphorescence and absorption, and that Lenard's results confirm this view, the properties of the cathode streams varying with the pressure at which they are produced. According to our ideas the difference is mainly one of velocity. The tendency to form the cathode stream exists at all pressures, and naturally the length of path, and, moreover, the average velocity over that path, varies with the degree of exhaustion. Everyone knows that the cathode stream does not commence suddenly, but gradually increases in strength as the exhaustion progresses, some few particles managing to pass over a considerable distance even in a comparatively poor vacuum. Now, for experimental reasons shortly to be mentioned, we may reasonably assume that phosphorescence effects, &c., are proportional to velocity of impact, and as there is good reason to believe that a stream formed at a low exhaustion will possess less final velocity than a stream formed at a higher one, and possibly less initial velocity, we should expect them to differ in phosphorescent power.

Moreover, Spottiswoode showed long ago that an apparently continuous cathode stream is really made up of sets of particles moving with different velocities, which could be separated from each other by magnetic deflection, and he found these groups to become more numerous as the vacuum improved. These effects are due to the intermittent nature of the discharge, and are apparently similar to the observations of Hertz. Spottiswoode threw the stream upon the sides of the tube by means of a magnet, and then obtained a succession of images instead of one only, thus, as Lenard says, forming a sort of spectrum. Spottiswoode's own words are (Royal Society, June 16th, 1881):—"We are led to the conclusion that the positions of the images are determined by the force with which the radiations are projected. In fact, we understand the various images are due to a succession of discrete discharges of successively diminishing strength."

Now, it is more especially upon his magnetic experiments that Lenard relies to confirm his etherial hypothesis, and it is therefore necessary to consider these carefully. Though, as Prof. Fitzgerald points out (*Electrician*, March, 1894), the very fact that a cathode stream is deflected by a magnetic field, makes it probable that we are dealing with material particles, for we have absolutely no reason to expect such an effect in the case of ether waves in vacuo. Lenard surrounded the tube in which the stream was produced (the originating tube) by a second, or observing tube, and allowed the stream to pass through the partition from one to the other. When the pressure in the observing tube was kept constant, while that of the originating tube varied, the magnetic deflections produced in the observing tube also varied. When the pressure in the originating tube was kept constant, it was found that the deflection remained constant in the observing tube through wide variations of pressure (from 33 mm. to ·021 mm.).

(*To be continued.*)

Lectures.—At the Newport Literary Society last week, Mr. C. J. Jenkin, manager at Nettlefold's Works, delivered an interesting address on "The Electric Current."

PRACTICAL COMPOUNDING OF DYNAMOS.*

By GEO T. HANCHETT.

If a shunt machine running at constant speed is required to supply a current to its load-circuit, a certain drop of voltage occurs below that which it gives when running at no load, provided that no rheostat or other means of adjustment have been used to rectify it. This drop of voltage is very nearly directly proportional to the current drawn from the armature, and is due principally to the fact that the extra volts needed to force the increased current through the armature itself are taken from the electromotive force of the machine, and apparently disappear from the terminals, and also because the drop of voltage from this cause deprives the magnet of a proportional amount of current, and hence weakens it. The armature of the machine loaded with many ampère turns, acts as a magnet in opposition to the field magnet, und this tends to weaken the field, and hence drops the voltage.

The electromotive force of any one dynamo depends upon two things, namely, its speed and the strength of its magnetic field. These volts thus generated are used for two purposes: First, to force the current through the external circuit; second, to force the current through the armature. Hence we see that if we demand of an armature an increased current we must provide extra volts to drive this current through the armature, if we wish constant potential at the terminals. Since the speed of the dynamo is constant, we must therefore increase the strength of the field.

If the armature has re-actions, and thus cuts down the field, we must provide additional strength to overcome this, also. Knowing the resistance of the armature, it is perfectly possible to calculate the number of extra volts necessary to force any current through it, but it is by no means so easy a matter to calculate the re-active effect of the armature on the field, for this depends on the winding of the armature, the position of the brushes (a variable), the shape of the pole pieces, the quality of the iron, and many other considerations.

Many writers have deduced complex formulæ which are supposed to take all these factors into consideration, and at the close of the demonstration say that owing to certain assumptions, which are not exactly in accordance with the conditions of practice, they are only useful in showing the mathematical theory of compounding. If used carefully and intelligently, these are of value, but the practical method here described is also useful.

The strength of the magnetic field of a dynamo depends upon the number of ampère-turns surrounding its magnetic circuit. Hence, if we wish to increase the strength of the magnetic field, we must increase these ampère-turns. It is obvious that a shunt coil cannot do this, for when unaided the current in it diminishes when the load comes on.

If, however, we have a coil which we can connect in series with the main circuit, it will increase in its magnetising power as the load comes on. We know how strong the main current will be at full load, but we do not know the additional ampère turns necessary to keep up the voltage. Therefore, we cannot compute the number of turns this coil should have. To practically determine the magnetising power of both shunt and series coils of a compound dynamo, place on the magnetic circuit coils of a known number of turns, all in series. Start the dynamo and separately excite these coils till the machine comes up to voltage. Then draw from the armature the number of ampères which it is proposed to use in exciting the shunt field of the completed machine. This is usually two to five per cent. of the full load current. Increase the current in the exciting coils till the machine is again at rated voltage, readjust the current in the armature if necessary, multiply the reading of the ammeter in the exciting circuit by the total number of turns of the exciting coils, and the result will be the proper magnetising power of the shunt coil in ampère-turns at no load. Continue to increase the current in the armature of the machine till the rated load is attained. Increase the current in the exciting coils till the rated voltage of the machine is reached, being careful to keep the current load the same. This voltage is usually from three to five per cent. more than the voltage at

* *The Electrical World*, of New York.

no load, because the machine should be *over-compounded* to make up for the loss in the line. The product of the ammeter reading by the number of turns in the exciting coil, will give the total number of ampère turns necessary, and the difference between this number and the ampère turns necessary for the shunt, plus its increase due to over-compounding, will be the number of ampère turns required for the series coils.

Divide the last named quantity by the rated current of the dynamo and the result will be the number of series turns required. This will be better illustrated by a practical example.

Suppose that we wish to compound a 33-kilowatt Edison shunt dynamo capable of supplying 320 ampères at 105 volts, at 750 revolutions per minute. Suppose that we wish to adjust it for 5 per cent. loss in the line. Suppose that on the field magnet are 3,260 turns, and that at no load a rheostat has to be inserted in series with the fields.

Start the dynamo, separately exciting the field, and allow it to come up to voltage at no load, 105 volts, having an ammeter in the shunt circuit. Suppose this current to be for simplicity's sake 5 ampères. Since in this case we propose to use our "experimental field coil" for the actual shunt field coils in the completed dynamo, we must draw from the armature 5 ampères, and see if the voltage of the machine is cut down. If this is the case we must mutually adjust current drawn from the armature and exciting current till they are both the same and the voltage of both 105. A good method in this case is simply to allow the dynamo to excite itself and when the rated voltage is reached take the shunt ammeter reading. Then separately excite and continue. Suppose that this adjustment results in a current of 5·1 ampères. The ampère turns on the magnet are then $5{\cdot}1 \times 3{,}260 = 16{,}626$. Now increase the main current to full load, 320 ampères. The voltage will drop. Increase the exciting current till the voltage comes up to 105 + 5 per cent. of 105 = 110·25 volts, being careful not to let the main current increase while so doing. Now read the ammeter of the exciting coils again, and suppose it now reads 6·3 ampères.

The total ampère turns are $6{\cdot}3 \times 3{,}260 = 20{,}538$. From this we must subtract the ampère turns of the shunt at full load. At full load the shunt supplies 5 per cent. more ampère turns than at no load, due to the fact that it is subjected to 5 per cent. more voltage; hence this is 16,626 + 5 per cent. = 16,626 + 831·3 = 17,457·3.

The ampère turns for the series coils are 20,538—17,457·3 = 3,081. Dividing this by the main current, we have the number of turns required, $\frac{3{,}081}{329} = 10$ turns nearly. We therefore wind five turns on each limb of the magnet and connect them in series.

It is possible to use this method in the case in hand without separate excitation, but for simplicity's sake and also to make the case more general, separate excitation was considered.

As the series coils are simply regulators for the reactions of the armature and the lost volts consumed in driving the current through the armature, the excellence of the design of a machine is, roughly, inversely proportional to the number of turns on the series coils, for the lost volts and armature reactions of a good machine are very small.

A machine may be heavily over-compounded or have a number of series bobbins in parallel, and in such a case, when applying this approximation, due allowance must be made.

THE MEASUREMENT OF VARYING CURRENTS.

Mr. Albert Crehore has recently presented a paper to the American Institute of Electrical Engineers upon a "Reliable Method of Recording Variable Current Curves," an account of which is given in *Electricity*, of New York, Vol. vi., No. 24. The amount of *reliance* which is to be placed upon a speculative method must always itself be speculative; in its present form there seems to be so much that is hypothetical in the proposed arrangements that it may be well to await further results before accrediting them with too much faith. The problem is to "measure the exact current which flows in a conductor at any instant of time, and record all the irregular changes to which it is subject." Mr. Crehore points out that to attain such perfection in measurement it is necessary to devise an apparatus which does not require the movement of so-called "ponderable matter;" and he looks to the rotation of the plane of polarisation of light as the solution of the difficulty. Faraday's discovery was that if a beam of polarised light is passed through some substance in the direction of the lines of magnetisation within that substance, there is a rotation of the plane of polarisation in a direction which is the same as the direction of the current required to produce such a magnetic field. The direction of rotation is unaltered, therefore, whether the light beam advances in the same or the opposite direction to the magnetisation, so that a beam reflected backwards and forwards through the substance several times has its rotation increased by equal amounts each time. If the direction of the ray of light be at right angles to the lines of magnetisation, there is no rotation produced. The amount of this rotation was expressed by Verdet as follows: "The rotation of the plane of polarisation for mono-chromatic light is, in any given substance, proportional to the difference in magnetic potential between the points of entrance and emergence of the ray." That is, it is equal to some constant multiplied by this difference of magnetic potential; this constant is known as Verdet's constant. If light is passed through a polariser, and then through a tube containing the substance used (around which is wound a coil of wire), and thence through the analyser, an observer would find complete darkness upon looking through the analyser in the crossed position; but if, without moving the analyser, a current is sent through the coil on the tube, light appears to the observer. This is because the plane of polarisation has been rotated by the current, and, practically, the prisms are no longer crossed. Now let the analyser be rotated while the current is still flowing; the observer will see a series of colours through the analyser, a different one for each position of it; but as long as the current flows, he cannot produce darkness again by any amount of rotation of the analyser. This effect is due to the rotation of the light of different wave-lengths by different amounts, so that when the analyser is turned through an angle corresponding to light of a given wave-length, that light only is prevented from passing through the analyser. The law which tells the amount of rotation given for different colours was arrived at by Maxwell from his theory of molecular vortices, and Verdet's constant is shown to be approximately inversely proportional to the square of the wave-length; we have thus a relation between the angle of rotation, wave-length, and current. By suitable calibration of the analyser, Mr. Crehore suggests that the values of the currents may be defined, and he proposes to record them by photographic means. There is nothing very obviously reliable in this proposal, nor is there much that strikes us as being original; the suggestion, however, may possibly lead to practical results.

THE CAPILLARY-ELECTROLYTIC SLUICE IN THE EXTRACTION OF GOLD.*

By Jos. H. Jory.

Aside from all carelessness and inexpertness of the manipulators of gold bearing rock, there are two general causes which go to produce the enormous loss in gold which occurs after the ore has been taken from the mine—a loss estimated by the best authorities to exceed an average of 50 per cent.

In the first place, the extreme fineness in which the particles of free gold are often found renders its extraction by the older methods practically an impossibility, for the reason that gravity is depended on to bring the gold into contact with the mercury placed for its amalgamation, when the fact is that gold in a minutely divided state, and held in suspension in slimes, is but little influenced by that force, and is often carried several miles after passing into the stream before being deposited. The genius who conceived the idea

* From the New York *Engineering and Mining Journal.*

of skimming the creeks in Colorado to obtain the cream of the output of the mills in the vicinity, however successful he may have been, was certainly not lacking in observation.

The second, although generally imagined to be very different from the former, is in one respect at least quite similar as an ultimate cause. In this case the precious metal is so associated with other minerals which conceal and imprison it, that the ore is said to be "refractory" or "rebellious." I have used the terms, conceal and imprison, advisedly, for there can be no reason to doubt what most good metallurgists concur in holding, viz.: that gold exists in a metallic state in every form of ore in which it occurs, and though generally alloyed with other metals, it is always extraneous to the oxides or sulphides of those or other metals.

When associated with iron or copper bisulphides, although some of the gold occurs free and coarse and is readily amalgamated, much of the metal is extremely fine, and appears to form the nucleus on which the pyritic crystals are built. So fine, indeed, is some of the gold thus occurring, that it would appear to be the unconsolidated precipitate from a solution. When the gold is freed from these "sulphurets"—chemically—by roasting, the sulphur is driven off by heat and the pyritic crystals are decomposed. But the gold still in a metallic state remains covered more or less by the resulting oxides of the baser metals, and not in a state to be amalgamated in the usual manner; thus rendering further chemical means necessary for its recovery.

That the gold may be freed also by mechanical means cannot be doubted. The following laboratory experiment—as one of many differing but slightly in result—goes to establish this and some other of the propositions made above.

A quantity of pyritic ore containing iron and copper sulphides, with a small percentage of galena, and assaying $104.85 in gold and nearly 2 ozs. in silver, was crushed coarsely in a mortar and divided into three equal parts. Sample 1, on being treated in the usual manner with potassium cyanide, yielded only 49 per cent. of its value in the solution; sample 2 was thoroughly roasted in a muffle, and on being treated with cyanide, yielded a solution of 97 per cent. in value; sample 3, unroasted, was again placed in the mortar and triturated to an impalpable powder; this was also subjected to the cyanide process, and yielded 98½ per cent. of the assay value. This extreme pulverisation of pyritic ores and other rock containing gold in an extremely divided state has, however, hitherto given extremely poor results practically, either in chemical or mechanical and amalgamating methods, for the reasons that in the former case a paste is formed almost impervious to chemicals, and in the latter because the mercury and gold are converted into "float," which is carried away in the stream and lost. A foreign company, having a large display at the World's Fair of mining and milling apparatus, appreciating the losses occurring from this source, advertises the prevention of float by having its mills adjusted so as to crush coarsely. This method is not quite original, however, as many of our large Californian mills have practised it for years, with the result that numerous arrastras worked by Italians and Mexicans are now reaping a rich harvest by running through the tailings of those mills. The fact is, the millman is placed between the two horns of a dilemma; he must either crush coarsely, and lose some of his gold as float and much as tailings, or he must crush finely, and lose some as tailings and much as float.

The capillary-electrolytic sluice offers a solution to this problem in providing an apparatus that, dealing with metals in the finest possible division, renders impossible any loss of the minutest particle of gold in either free milling or extracted ores, and makes entirely unnecessary the slow and costly processes of chemical extraction.

The method is applicable to quartz mills, beach mining, or hydraulic mining. In the former case much cumbrous machinery now used as concentrators and amalgamators may be dispensed with, so that either in labour or power no expense will be added to the free milling methods now employed, while the resulting product will be from 10 to 50 per cent. increased. As applied to hydraulic mining the 60 per cent. now lost as float in the slickens may be almost entirely saved with but slight additional expense.

The capillary-electrolytic sluice, as applied to the extraction of gold, consists of a series of amalgamated copper plates, set almost vertically in a sluicebox, in such a manner that very narrow "capillary" passages are formed between the plates; flood-gates placed at each end preventing the passing of fluids except through these passages, the widths of which are controlled by a hand-screw acting on simple adjusting mechanism.

The copper plates used are 12 × 14 inches, with a thickness of ⅛-inch, and are 2 inches apart when exactly vertical; when adjusted, however, they incline at an angle of about 45°. The number of plates, and consequent length of sluice, are dependent on the flow which the apparatus is intended to control. A sluice of 50 plates has been found a very convenient size, and a number of such is preferable in large mills to one or two of larger dimensions. The slimes or water carrying the particles of gold flow into the sluice, and after attaining such depth as the capillary passages are adjusted to, become exactly equal to the flow into the sluice, and thus an overflow is automatically prevented.

The capillary passages being extremely narrow—about $\frac{1}{30}$th of an inch generally—every particle of metal must of necessity be brought into intimate contact with the amalgamated surfaces. The contiguity of the plates also calling into play the little considered but very subtle molecular force, capillary action, which, in this instance, acts powerfully in attracting to the plates the metals with which they are in affinity.

The electrolytic action of the sluice is produced by passing a current of electricity through the series of plates, and the flowing fluid passing through the capillary passages between.

The action of the electric current is twofold—first, in carrying and holding to the plates the particles of the precious metals contained in the flow in a manner analogous to the processes of electroplating; and, second, in decomposing the films of oxides or sulphides adhering to the amalgam or to the flowing particles, that might otherwise prevent a free amalgamation.

Under a continuous current of electricity some heterogeneous particles, under certain conditions of the ore, may adhere to the plates even when the affinity is but slight. This difficulty has been obviated by employing an alternating current, under the vibratory action of which any adhesion of the electro-negative elements is prevented, while at the same time those metals of the highest electrochemical character, such as gold, silver, platinum and mercury, adhere to both surfaces. The impact given by the vibratory action also produces a more dense amalgam and a firmer adhesion than would be otherwise the case. This is of some advantage where the gold is much alloyed with silver or lead.

It will be seen that the capillary-electrolytic sluice is a continuous process that may be applied to any wet-crushing mill; the only condition being that the slimes shall be delivered in the finest possible state of mechanical division to secure the best results; while, for hydraulic or beach-mining work, all coarse gravel and sands must be screened from the flow before entering the sluice.

As before stated, the process presents no increased cost to milling operations, while the extraction of gold is infinitely greater. As compared with chemical methods, it is more certain in result, affords less opportunity for loss, is more easily adapted to the changing character of the ore, is more rapid, and presents none of the great elements of expense attending those processes.

ALTERNATING CURRENT MOTORS.

By RANKIN KENNEDY.

Some time ago I contributed two articles on this subject, describing the fundamental principles of the alternating motors, acting by induction only.

The difficulties in the way of starting up the single-phase motor were pointed out.

The General Electric Company, of America, have introduced a motor for working on single-phase circuits, which, by the way, they are pleased to call monocyclic circuits, this no doubt will be followed by polycyclic circuits, and presently we will require a cyclic dictionary, compiled by an American

electrician, to find out what it all means. In this case, monocyclic, we find, means an ordinary single alternating current, and the motor is an induction motor which will run on with a single alternating current after it has been started by a pair of currents differing in phase by about 90 degrees. It is claimed that no polyphase, or should we say polycyclic, currents are required to work this motor or even to start it, and this claim is made in the face of distinct directions in the construction of the motor to provide supplementary coils for another current for starting purposes, which current is 90 degrees lagging behind the monocyclic (*sic*) current.

This may not be polyphase working, it is likely called polycyclic, a difference like that between tweedledee and tweedledum. Here is a modified description of the motor: In the induction motor, fig. 1, one coil, A B, is excited by a

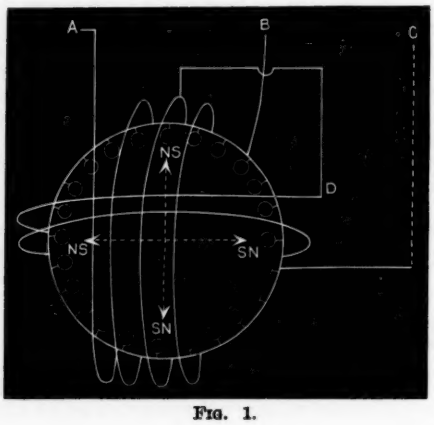


Fig. 1.

single-phase alternating current, in the short-circuited armature coils beneath field coil, A B, a secondary current is induced, which lags 90 degrees behind the magnetism produced by coil A B. This secondary coil polarises in the same direction as A B, and thus does not give a rotating torque. If, however, by some external means a magnetic pole is produced at right angles with the polarisation of coil A B, and displaced in phase, this pole is just in the position to give the maximum torque with the induced current in the armature, and thereby starts the motor at full torque.

As will be seen, a second current in a different phase is needed for such self-starting induction motors, from a supplementary field coil, which requires the expenditure of sufficient magnetising power in the supplementary coil, D C.

While such a motor is running, the induced current in the armature, carried along by the rotation, due to the short-circuited conductors surrounding the armature, produces this displaced pole, and even induces an E.M.F. in the coil, D C, sufficient to give a magnetising current for the supplementary coil of any other motor running from the same mains, A B, by connecting them with the corresponding terminal of the other motor.

Thus, by connecting all the single-phase motors with supplementary coils, D C, with each other by an equalising wire, C, as long as one motor is running, any other motor is able to start at full torque. This equalising wire, C, conveys no energy current, but merely the small amount of magnetising current required in starting, and thus needs to have a small cross section only. Carrying, however, wire C back to the generator and connecting it there with a small supplementary coil wound on the generator armature, the magnetising current required for starting the motor by means of coil D C can be supplied by the generator also, and thus the first motor starting on the system will receive the magnetising current from the generator, and all the other motors indiscriminately from the generator or parallel running motors, thereby making these single-phase motors self-starting under full load and over load. It will thus be seen that where light only is required the ordinary two supply wires are alone necessary; but where motors are to be operated, only then is the third or power wire called into requisition.

It also requires a third wire to form a motor circuit, run throughout the district where current is supplied for motors; and, as will be seen from the description, the generator is a two-phase generator, supplying a main motor current in one phase and a smaller starting current in another phase.

The idea is good, for in any alternating current supply a single separate wire has only to be run to enable these motors to work, and the Brown motor could also be worked on this system; and most important of all, any reversed alternator would work as a synchronising motor on this system, for, by adding a few supplementary coils, they also could be started up in the same way; the author proposed this scheme in 1890, and Mr. James Swinburne, I believe, has also proposed something of a similar kind.

If supply authorities would consent to run a third wire for motor purposes in alternating district supplies, the motor problem would be solved, so far as rendering it possible to start them on load and run them economically.

But, like continuous current motors which can be used on ordinary continuous circuits, the alternating motor *would* not be much used even if it *could*, the cost of electric energy is fatal to the use of motors on supply circuits. All the alternating motors wanted in Britain in a year would not keep a small firm from starvation even if they secured the contract for the supply of the whole of them. This fact accounts in itself for the want of interest displayed by English engineers in alternating current motors.

Nearly all motor work on this side is to be found in isolated plants, where the power is cheap and a complete plant is laid out specially for the purpose.

REVIEWS.

A Journey in Other Worlds: A Romance of the Future. By John Jacob Astor. London: Longmans, Green and Co., 1894.

"How much more interesting it would be if, instead of reiterating our past achievements, the magazines and literature of the period should devote their consideration to what we do *not* know!" Thus says Mr. John Jacob Astor in his preface to "A Journey in Other Worlds." In his "magazines and literature of the period" he would naturally include the Electrical Review, and would expect our readers to acquiesce! The laws and truths of physics and chemistry which have been discovered at infinite pains must be discarded. Science must be set down and the worship of Ignorance*—its converse—must prevail. Mr. John Jacob Astor will not like our interpretation, but what other synonym can be used? The topsey-turveydom into which this daring revolutionist would land us baffles the most extravagant imagination. In illustration of the effect upon literature of devoting consideration to "what we do not know," Mr. John Jacob Astor has written a book. "Of making books there is no end," and amongst the multitude, one more does not matter much. Born of the vanity of man they provide a certain amount of employment for printers, bookbinders, and paper makers.

But in spite of the preface with its puerile platitudes about the "protracted struggle between science and the classics," we have felt it our duty to read the book right through. We do not advise our readers to do so, however, unless they are prepared to treat the thing as a joke—and weak at that. Indeed, it is difficult to say to whom this book should be recommended. Some of it, especially that in which the style of Jules Verne and some of his ideas too are plagiarised, might do for small boys; whilst Book III., by which term is dignified the last hundred pages, might find favour with extremely young women whose tastes for the morbid and gruesome have been titilated by a superficial acquaintance with such works as "A Romance of Two Worlds," "In the Midst of Life!" "Letters from Hell," and others of that order. We can conceive, too, that the type of man whose intellectual *pabulum* consists of *Pearson's Weekly*, and similar pennyworths, might swallow down some of Mr. John Jacob Astor's "scientific" deliverances with the greatest gusto. There is, however, no coherency in the book,

* If Mr. John Jacob Astor prefers a more euphemistic expression, we will present him with the word "Nescience," which will more politely signify the negation or absence of knowledge.

it might easily be the production of two or three garret "ghosts" working under the instructions of a person having a smattering of most of the sciences and an extremely rampant imagination. It must be admitted that now and then you happen upon a bit of very fine writing, but, as the mass of it is so mawkish, you begin to suspect that you have read something very like it before. These are only some of the impressions left on our minds; we do not care to state them all.

The main purpose of the book is to describe a journey taken by three Americans to the planets Jupiter and Saturn, and what adventures befell them. These enterprising gentlemen are not Yankees of to-day; they live in the year 2000, A.D., and so really ought to have made such progress in mental evolution as to be beyond our criticism. Colonel Bearwarden is one of them, and is described as the President of the Terrestrial Axis Straightening Company—a company that proposes to so alter the inclination of the axis of the earth as to produce a genial climate in all parts of it. Prof. Cortlandt is a government official appointed to investigate the company's calculations, and Richard Ayrault, an honorary vice-president of the company, is the third traveller who jauntily sets off with the other two for a visit to Saturn and Jupiter, chiefly because by the time he expects to return his "young lady" will have graduated, and will then be ready to marry him. Though what qualifications for matrimonial bliss graduation confers is not quite clear. The journey across space is made in a kind of cylinder of special construction, which, though nobody shoots it off, the author calls a "projectile," possibly because the Jules-Vernian *afflatus* clings to him in spite of his almost frantic efforts to be original. A wonderful force, called "apergy," is used for propelling the cylinder. "With this force, obtained by simply blending negative and positive electricity with electricity of the third element or state, and charging a body sufficiently with this fluid, gravitation is nullified or partly reversed, and the earth repels the body with the same or greater power than that with which it still attracts or attracted it, so that it may be suspended or caused to move away into space." *Sic itur ad astra!*

In order to prepare our minds for this remarkable achievement, Prof. Cortlandt is made to give a sketch of the world in the year 2000. This is so remarkable, that we must needs dwell upon it for a while, for since "electricity in its varied forms does all the work, having suspended animal and manual labour," it will be interesting to see to what our profession will have come to a century hence. We learn that all the waterfalls and great tidal falls are harnessed to dynamos; that "every exposed place" is "crowned by a cluster of huge windmills"; that "much of the electrical energy in every thunderstorm is captured and condensed in capacious storage batteries": that, in short, every known source of power is made to yield electric current. The electricity is made to run "ships and water-spiders, railways, and stationary and portable motors," and also heats "the cables laid along the bottom of our canals to prevent their freezing in winter, and for almost every conceivable purpose." For operating the electric railways, "the current is taken from an overhead, side, or underneath wire, directly through the air, without the intervention of a trolley; and the fast cars, for they are no longer run in trains, make five miles a minute. The entire weight of each car being used for its own traction, it can ascend very steep grades, and can attain high speed or stop very quickly." A clever conception, isn't it? "Another form is the magnetic railway, on which the cars are wedge-shaped at both ends, and moved by huge magnets weighing one thousand cwts. each, placed 50 miles apart. On passing a magnet, the nature of the electricity charging a car is automatically changed from positive to negative, or *vice versâ*, to that of the magnet just passed, so that it repels while the next attracts. The successive magnets are charged oppositely, the sections being divided halfway between by insulators, the nature of the electricity in each case being governed by the charge in the magnet. To prevent one kind of electricity from uniting with and neutralising that in the next section by passing through the car, at the moment of transit there is a dead stretch of fifty yards with rails not charged at all between the sections. This change in the nature of the electricity is repeated automatically every fifty miles, and obviates the necessity of revolving machinery, the rails aiding communication. Magnetism being, practically, as instantaneous as gravitation, the only limitations to speed are the electrical pressure at the magnets, the resistance of the air and the danger of the wheels bursting from centrifugal force." Needless to say, these little difficulties vanish before the skill of the engineers in the year 2000 A.D. The electrical pressure at the magnets "can seemingly be increased without limit"; the atmospheric resistance is reduced "by running the cars hermetically sealed through a partial vacuum in a steel and toughened glass tube"; while the danger of the wheels bursting "has been removed indefinitely by the use of galvanised aluminium."

The marine architecture of the year 2000 proves to be of a most remarkable character. The vessels are for the most part shaped like spiders, the "legs" of which are moved by means of electricity, storage cells being carried on board for that purpose. For flying there is the aeroplane, the motor power for which is "obtained from very light paper-cell batteries, that combine some qualities of the primary and secondary type, since they must first be charged from a dynamo, after which they can supply full currents for 100 hours, enough to take them around the globe—while partly consuming the elements in the cells." . . . "The motors are so light that they develop 2 horse-power for every pound of their weight." Unfortunately no specification of this motor is given, or we would recommend it to the notice of Mr. Maxim. The batteries are very wonderful, their principal parts consist of "limestone and clarified acid," and they are so perfected that "eight ounces of battery yield one horse-power for six hours."

Electric phaetons are all the rage in the year 2000 A.D.; they have three and four wheels "and weigh, including battery and motor, 500 to 4,000 pounds." "To recharge the batteries, which can be done in almost every town and village, two copper pins attached to insulated copper wires are shoved into smooth bored holes. These drop out automatically by fusing a small lead ribbon, owing to the increased resistance, when the acid in the batteries begins to 'boil,' though there is, of course, but little heat in this, the function of charging being merely to bring about the condition in which part of the limestone can be consumed, the batteries themselves when in constant use requiring to be renewed about once a month." . . . . "On reaching the top of a long and steep hill, if we do not wish to coast, we convert the motors into dynamos while running at full speed, and so change the kinetic energy of the descent into potential in our batteries."

Although it seems a wilful waste of good space to quote more of the wonders imagined by Mr. John Jacob Aster, we cannot refrain from alluding to the "*magnetic eye*." "Magnetic eyes are of great use to miners and civil engineers. These instruments are something like the mariner's compass, with the sensitiveness enormously increased by galvanic currents. The 'eye,' as it were, sees what substances are underground, and at what distances. It also shows how many people are in an adjoining room—through the magnetic properties of the iron in their blood—whether they are moving, and in what direction and at what speed they go." Such an instrument beggars criticism. Marvel upon marvel succeed each other, till finally we have our breath taken completely away by the statement that "through the potency of electrical affinity we form wholesome food-products rapidly, instead of having to wait for their production by Nature's slow processes!"

Well, the three adventurous travellers, who in this age of wonders conceive the notion of a trip to Jupiter, get into their "projectile" one day, apply the "apergy," and while Sylvia, Ayrault's sweetheart, waves her handkerchief, away they soar on their journey of 380,000,000 miles. Travelling at the rate of 1,000,000 miles an hour, they soon make headway, and, after a little comet dodging, &c., they finally alight on Jupiter, and, like nineteenth century Englishmen, immediately take their guns and "go out and kill something." As Jupiter is in the carboniferous or Devonian epoch (Mr. Astor is not quite certain), the game turns out to be very fine and large. Mammoths are knocked over with explosive balls, which, as they explode, heave out "A half-barrelful of flesh and hide." Such is Mr. Astor's realism. After blazing away till they are tired, they camp for the night. In describing the bivouac, we would suggest the author's indebtedness to Mark Twain's travesty of the story of King Arthur and the Round Table, for they arrange around them a double line of electric wires in a circle; and, "whenever a

snake's head (Jupiter is not like Iceland as regards these reptiles) came in contact with one wire, while his tail touched the other, he gave a spasmodic leap and fell back dead. If he happened to fall across the wires, he immediately began to swizzle, a cloud of smoke arose, and he was reduced to ashes."

Of the jelly-fish that was capable of rising out of the water and floating a luminous mass in mid-air (by means of apergy, we suppose); the great ant, that could tackle an elephant; the tortoise, on whose back they went for a ride; the dinosaurs, the pneumatic reptiles; the singing plants; the carnivorous flowers, which the travellers encountered in their rambles about Jupiter, it must be admitted that they are weird creations, and that the author in his description of them, becomes appropriately uncanny. On Saturn the travellers fight with dragons and are saved by a friendly earthquake; but, really, the lively adventures of this kind are exceeding few. On Jupiter, much of the time is spent in geological discussions. On Saturn they meet a disembodied spirit who discusses ethics and religion with them *ad nauseam*, gives Cortlandt a peep into the future, where he sees his own funeral, and allows Ayrault to survey the miseries of hell. No human life was met on either of the planets, but Saturn appears to have turned out to be the *locus* of the sheol.

The last few chapters of this remarkable book will probably be skipped by everybody but the suitably morbid, and even they will experience a shock when the inflated style adopted by the author suddenly fizzles out like a "squib without a bang." The travellers get tired of their spiritual acquaintances on Saturn, or perhaps their store of apergy gets low. So away they go back to mother earth. They land (page 475); Ayrault meets Sylvia again, and (page 476) "three weeks later a clergyman tied the knot that was to unite them for ever." Sylvia then "went upstairs to change her dress, and when she came down she and Ayrault set out on their journey together through life, amid a chorus of cheers and a shower of rice." Cortlandt went back to his department at Washington, and Bearwarden "resumed his duties with the Terrestrial Axis Straightening Company, in the presidential chair."

The Practical Designing of Structural Ironwork. By Henry Adams. First series, revised and enlarged. London: E. & F. N. Spon, 125, Strand.

The author of this work is Professor of Engineering at the City of London College, and has within the last ten years issued in pamphlet form much of the matter which is now, with great advantage, issued in book form. A very distinct feature in the work is the almost entire absence of any unnecessary padding, in fact, the matter really consists of a series of numerical examples dealing with dimensions and prices with brief notes; an excellent selection of illustrations being included. The book is certainly an attractive one, though, possibly, practical engineers may here and there find an occasional formula the accuracy of which might be questioned.

Designing Ironwork. Second series. *Part I.—A Steel Bore Girder.* By H. Adams. London: 60, Queen Victoria Street, E.C.

This is a pamphlet of 26 pages by the author of the foregoing work, and will, doubtless, in time, be incorporated in a book of the same useful class.

CORRESPONDENCE.

Cyanide and Electrolytic Cyanide Solutions.

In the paragraph of my article, "*Cyanide and Electrolytic Cyanide Solutions*" (November 16th, 1894), incriminated by Dr. Gore, I had not mentioned his name, but simply stated some extracts of the evidence of witnesses who denied that the action of cyanide as a solvent of gold was common knowledge; still, he jumped at me, saying that I had made an untrue statement, and it seems to me that he was most unjustified and was most unjust in writing "the statement in the first paragraph on page 588 of your Electrical Review of November 16th, 1894, 'that I affirmed in a most solemn manner that it was not previously known that gold was dissolved in cyanide of potassium,' is entirely untrue."

Qui s'excuse s'accuse. The only newspaper which gave a full report of the lawsuit instituted by the Cassel Gold Company was the *Financial News* of July 24th, &c., from which I extracted the following lines, which I published in my article, page 587, lines 65, 66, and 67, but without disclosing the name of Dr. G. Gore:—

"*Dr. George Gore, F.R.S., &c., said he never knew gold dissolved directly in cyanide of potassium for the purpose of forming a solution. Electricity was used in connection with electroplating.*"

I am not responsible for a newspaper report published months ago, and which Dr. G. Gore had plenty of time to correct.

Now let us see the *verbatim* report, which I could only procure a few days ago (page 101):—

Mr. George Gore, sworn. Examined by Mr. Bousfield.

1,113. Are you a Fellow of the Royal Society?—Yes.

1,114. And are you the author of a number of books on electro-metallurgy and electro-chemistry?—I am.

1,115. And have you had a large experience as a chemist, and especially in relation to the electro-metallurgy of gold and other metals?—Especially with regard to electro-metallurgy.

1,116. Perhaps it is hardly right for me to put it to you, but are you one of the first living authorities on this particular subject of electro-metallurgy?—I have devoted a great deal of my life to it.

1,117. I think you have had a great deal of connection with Messrs. Elkington, who invented electroplating?—Yes.

1,118. And you have done a great deal of work for them in connection with it?—Yes.

1,119. Practically, in the use of gold in the arts, for electroplating, or any other purpose, gold is required in solution, is it not?—It is in many cases.

1,120. And generally in the solution of cyanide of potassium?—For electrolytic purposes.

1,121. Have you ever known a solution of gold in cyanide of potassium practically *made by dissolving gold direct in the cyanide of potassium?*—Not by dissolving precipitated gold, but by dissolving gold anode.

1,122. That is with electric action?—Electrolytic action.

1,123. I meant without the aid of electricity, a simple solution. *Have you ever known gold simply dissolved in cyanide of potassium*, in order to produce the solution of gold?—A gilding solution you mean?

1,124. Yes.—I have not.

Now I ask any sensible and impartial reader, has Dr. G. Gore, one of the first living authorities on this particular subject of electro-metallurgy, said or not, although in a reticent manner by referring to gilding only, that *he did not know that gold was dissolved in cyanide of potassium?*

Why did he write to the Electrical Review to declare in a most solemn manner that my *statement was untrue?*

It is rather late for him to affirm that he knew that gold is dissolved by cyanide of potassium; and if he knew it, why did he not say so plainly in Court? Why did he not quote passages of the books in which cyanide of potassium is described as a solvent of gold?

This is a case of self-defence. Dr. G. Gore wrote to the Electrical Review that what I said was untrue; I believe I have proved the contrary.

E. Andreoli.

Electro-Deposition of Gold.

Mr. A. Weightman, who says that the experiments he has been conducting lately agree to a large extent with those made by M. Von Gernet, tries to find fault with my remarks on the Siemens process.

The way in which he says, "The first query Mr. Andreoli raises is as to the nature of the ion (incorrectly called 'metalloid') liberated at the + pole," would lead one to suppose that the word metalloid was used by me. It is the reverse.

"The nature of the ion," he goes on, "will apparently vary with the strength of solution, oxygen being liberated with a weak, and *cyanate* with a strong solution."

Cyanate cannot be *liberated* at the + pole. There is something wrong in this sentence.

Given that the circulation of a liquid is *essential*, I pointed out that in this particular case there was *nothing special* which could facilitate the operation. This is really what I wanted to show, viz., that the electro-deposition of gold

described by M. Gernet is the old process of electroplating in the usual way, circulation, &c.

The use of iron anodes is known. If Mr. Weightman uses carbon on a practical scale, he will find that the disintegration is more serious than he thinks. Let him work, on a practical scale, his "good arc lamp carbons" for a fortnight, and if then they can be bent, his arc lamp carbons will be useful for incandescent lamp filaments.

In my opinion, the 600 ampères mentioned by M. Gernet would be a more efficient rate than the 60 ampères proposed by Mr. Weightman.

Mr. Weightman should like very much to see a practical electro-chemist come forward with some definite experimental result on this subject. Let us hope he will soon be satisfied, and that the new process will be both efficient and original.

E. Andreoli.

The Coal Question and the True Value of the Fuel Economiser.

Referring to your able criticism on the above pamphlet, in which you express the opinion that the same result would be got by subdividing the economiser into a few blocks of several rows each, I think that, while thoroughly grasping the importance of the counter-current theory, you have rather overlooked the main factor in my system, and by far the most important, which is, the circulation of the water against the hot sides of the pipes. I need not take up your valuable space by describing this here, as anyone interested can read the pamphlet for themselves, but I wish to point out that the value of this circulation bears a certain ratio to the rapidity of it, and therefore if we could circulate the water consecutively "up" each pipe, the acme of the system would be reached, but as this, owing to provisions for safety and a blow-off, is practically impossible, the next best thing is to take each row of pipes consecutively, in order to get the greatest possible speed and turbulence of the water, which is what I claim to have attained by my system. Further, this turbulence is an important factor in sustaining the efficiency of the apparatus by keeping the inside surface cleaner than the old system, where the water is almost stagnant.

Further, touching the question of corrosion, my suggestion to use an old economiser for the preliminary heating of the water cannot always be followed, and where a new economiser is used, the employment of the block system means, within a given period, the destruction of every pipe in that block, instead of, in my case, only the pipes of the first row, and as total friction in a large economiser, on my system, is only some 5 to 8 lbs. (a quite inappreciable quantity, being only some 5 per cent. to 10 per cent. extra work on the pump), I can see no reason why the full value of the circulation system should not be utilised.

James G. Calvert,
(Calvert Circulation Economiser Company.)

P.S.—Kindly allow me to correct the closing remark in your article, in which you state that I incline to think a temperature of 250° as very good. The very reverse; I consider it *very poor*, and a distinct proof that either the economiser is not doing its work, or that the relative proportions of the boilers and economiser are not correct.

The Incandescent Gas Light.

Your editorial Note upon my letter of the 9th inst. calls for a reply, which I will make as briefly as possible.

You question my argument as to the manner in which the hygienic question should be considered, but, as a hygienic question, surely the point to be considered is, what proportion of carbonic oxide is to be found in the atmosphere of an ordinary dwelling room, and when it comes out at $\frac{1}{260000}$th part, there does not seem to be any cause for alarm.

You wind up your editorial Note by requiring me to bring forward scientific facts and not mere assertions. I think you must be confusing me with the writer in the New York journal upon whom you seem to rely, and who is more picturesque than accurate. For instance, when he says that "the results of combustion remain just as deleterious and poisonous as ever." If he means that this is the case with the Welsbach burner as compared with ordinary gas burners, he is talking rank nonsense; and when he says that the use of the "Welsbach" burner makes no difference except to "*in*hance" (*sic*) the harm done, he adds a direct mis-statement to nonsense.

I have not claimed that the incandescent gas light has the coolness of electric light; I merely refuted, and successfully refuted, the misleading and false deductions made, by certain interested and prejudiced persons, from the results of Mons. Grehant's investigations, and claim that practically the incandescent gas light does not vitiate the atmosphere, as the poisonous products of combustion (if present at all, which has not been proved) are present in such infinitesimal proportions as to be practically non-existent.

You claim that the arc light is cheaper than the incandescent gas light, but the Inspector of Lighting in Glasgow (Mr. Hamilton) reported that while with the former it would cost £78 to light a certain area for a year, it could be done by the latter for £17, or less than one-fourth the cost. This *practical fact* somewhat demolishes the force of your mere assertion.

L. de Fonblanque,
Secretary, The Incandescent Gas Light Company, Limited.

[It is useless to waste time in argument with people of M. de Fonblanque's stamp. The *practical fact* which demolishes our mere assertion is an instance of its inutility. If Mr. Hamilton had pitted an ordinary batswing burner against the arc lamp, of, say, 2,000 C.P., the economy would have been still more pronounced.—Eds. Elec. Rev.]

Harmonic Call Bells.

Will you permit me to say, relative to harmonic call bells, in reply to Major Bagnold, Royal Engineers, in your issue of October 26th, that my device was sent to the *Electrical World*, not as a fully completed invention, but as a suggestion for theoretical consideration.

I had not the experimental facilities to give such apparatus scientific investigation, on which to base commercial form.

It was invented by me in 1886, and a sample bell was made in 1891 by E. S. Greeley & Co., of New York.

The statement "to make it ring, one of the pole-pieces must be removed," is probably correct.

I was not aware that the device had been patented in England or elsewhere by Major Bagnold in 1891, and that a considerable number had been sold during the last three years.

S. D. Mott.

Passaic, New Jersey, *November 6th*, 1894.

Electric Lighting of Donnybrook Fair.

Referring to the letter of Mr. Arthur Percival in your last issue upon the "Electric Lighting of Donnybrook Fair," I beg to inform you that as the letter is full of inaccuracies and untrue statements, my clients have been compelled, for the protection of their interests, to commence proceedings against Mr. Percival for libel, and he has therefore been served with a writ to-day.

Trusting you will give this letter the same prominence in your paper which you gave to Mr. Percival's letter,

J. Cornelius Wheeler.

November 27th, 1894.

There is one paragraph of my letter, which appeared last week, I should like to modify a little, viz., that "at no time throughout the seven days was the electric light in any sense a success," as I have since learned from Mr. Elwood, of the Cork, Blackrock and Passay Railway Company, that one evening he stood by and directed the stoking of one or two of the engines, and, while he did so, those circuits may have been right. He also informed me that he adjusted the position of the dynamo so that the belt would stop on without guides. But he could not remain at the Fair long, as his arduous duties called him away.

I may add that I have received a writ in an action for libel at the suit of the installation company, which I have handed to my solicitor for procedure.

Arthur Percival.

The Progress of Electric Traction in Germany.

In perusing the criticism in your paper of the 16th inst., on our pamphlet, "Electric Street Railways with Overhead Conductors," we find that you consider our devices for line suspension and insulation, &c., unnecessarily heavy and large, whilst no weights are given for same, and the cuts showing the overhead material on page 27 of our pamphlet give, with exception of a neat picture, no further particulars.

We must, therefore, protest against the assumption that our devices do not compare favourably with those used by either English or American electric lines; and everybody who had occasion to examine our overhead material will confirm it, that our devices are smaller, and of inferior weight, than American patterns.

Allgemeine Elektricitäts-Gesellschaft.

[If our correspondents will refer again to our review, they will find that we said the devices *seem* unnecessarily heavy. They must remember that when we said that we had only the illustrations of their pamphlet before us.—Eds. Elec. Rev.]

Design of Large Alternators.

The letter of Mr. J. S. Raworth, published in your issue of the 23rd inst. has been brought to my notice.

The action for libel having been commenced by my clients, British Thomson-Houston, Limited, against Mr. Raworth by writ issued on the 19th inst., and served personally upon him on the 22nd. inst. (the day before your last issue appeared), and the matter therefore being *sub judice*, I am unable to discuss the merits of the case.

Henry F. Kite.

Theory and Practice in Electrical Engineering.

My attention has been called to Mr. Rankin Kennedy's article under the above heading, published in your issue for the 23rd inst., in which he instances Scarborough among places where the adoption of the alternating, in lieu of the continuous current system, cannot be justified.

As chief engineer to the Scarborough Electric Supply Company, I must point out that Mr. Kennedy appears to be altogether unfamiliar with the local conditions obtaining in that popular seaside resort.

The municipal area, within any portion of which my company can be called upon to supply electricity, contains some four square miles. It is most irregularly shaped, with an extreme length of nearly three miles. When the company was formed, about two years ago, the best positions for the supply station were most carefully considered. Only three sites in the least suitable were to be found—one, the most central, so far as the business quarter of the town was concerned, was nearly two miles distant from one extremity of the borough, and about 1¾ mile from a point to which we are at present supplying current. This site was also unsuited for cheap access of coal, and in other respects disadvantageous. The second site was even more eccentrically placed, was not large enough for the ultimate requirements, and had other disadvantages. The place finally selected, and now used, is not very far from the centre of the municipal area, is near a railway siding for coal, and affords facilities for water for condensing purposes. It is, however, a mile distant from the centre of the district where most of our consumers are located, and about two miles (measured along the line the mains have to go) to our present most distant point of supply.

Now, at the present moment, we are supplying the equivalent of 10,330 lamps of 8 C.P. We have spent altogether, including the freehold purchase of two acres of land, the making of a large condensing pond, the erection of buildings sufficient for a much larger output than we have at present, and for machinery, mains, meters, transformers, accessories, and formation expenses, about £25,000. We are thus capitalised at less than £2 10s. per 8-C.P. lamp connected, which, in any case, would be a very low figure, and especially so when it is borne in mind that we have laid over seven miles of mains of the most substantial description, and on a scale that will admit of a large increase in the number of lights supplied.

In the light of the above information, I do not think that any competent engineer will agree with Mr. Kennedy's view that Scarborough is a place suited for the low tension system, a view which it seems to me he must have put forward without a sufficient knowledge or consideration of the local circumstances.

In any case it would be interesting to know how he would arrange to supply our consumers on the low tension system at anything like our low capital cost.

A. A. C. Swinton.

November 27th, 1894.

Electric Cooking of Institution Dinner.

It may interest your readers to know that we supplied seven large electric ovens, four hot plates, and other electrical apparatus for cooking the above dinner. We had some difficulty at first in convincing the chef that cooking could actually be carried out by electricity, and he was so incredulous that he demanded a trial beforehand. Of course, he was soon convinced of the practicability of the matter, and in the end he cooked 16 saddles of mutton, 30 brace of game, and numerous small dishes. Several other dinners served at the same place were also partly cooked by electricity, for the result was so good that the chef did all he could that evening by the aid of our apparatus. As a proof that the apparatus gave him perfect satisfaction, the chef has written us as follows:—

I beg to inform you that, as a practical cook of many years' standing, I felt rather doubtful of cooking being done by electricity, but after having used your roasting stoves and other apparatus, I am not only convinced, but astonished to see how well the joints can be roasted, and in a shorter time than by gas or before a range.

We give the above, so that members who were unable to see the actual cooking operations carried out may know how the food was prepared, and with what successful results.

Crompton & Co., Limited,
H. J. Dowsing, *Branch Manager.*

Is a Board of Trade Licence Necessary?

I should be very much obliged if you would be kind enough to give me any information on the following. We are desirous of supplying the electric light to a hotel about 200 yards distant from here, and to do so we should have to cross the main road with our cable. Is it necessary to get a licence from the Board of Trade to do this, providing we get the sanction of the local authority to cross the road? We only want to get the light to this one place. Should we want to take it to any more houses, I suppose we should be compelled to get a licence. Of course, we should use underground cables. Thanking you if you could spare space for a reply.

G. A. E.

[If the highway authorities give permission to cross the road, it will not be necessary to obtain a licence. The cable must, however, be laid in accordance with the Board of Trade regulations, for the safety of the public, and for the protection of property of the Postmaster-General.—Eds. Elec. Rev.]

Lighting Installations.

I hasten to correct two important errors in my paper on "Lighting Installations," and also in the discussion printed in your current issue.

First, I am made to say that the fact of a consumer adopting the five-wire system saves "current;" this should obviously read "copper."

Then with reference to the case of the Free Trade Hall; the metering was done by one Ferranti meter (not two Thomson), connected on the positive outer, the reading being multiplied by four. It is true that there is now fixed a Thomson five-wire meter, and by comparison with the number of units registered under the old system, the number now registered seems excessive; but it must not be taken that this fact reflects any discredit on the accuracy of the meter.

H. A. Henderson.

Manchester, *November 26th*, 1894.

Concentric Wiring.

We have only just noticed in your report of the *Proceedings* of the Northern Society of Electrical Engineers, contained in your issue of the 23rd inst., that mention was made of our system of concentric wiring. On page 639, in the second column, you report that in reply to Mr. Fawcus's enquiry if anyone had any experience with Andrews's system of concentric wiring, Mr. Nisbet responded by informing that Society that amongst one or two points in our system worthy of attention, one was, that owing to the iron return the self-induction with alternating currents is very great, and in consequence the resistance of the return conductor is very much higher.

We hasten therefore to correct this popular error. Some 12 months ago a test was carried out under the supervision of the City Company's engineer, Mr. Nisbet, in the crypt of St. Botolph's Church, Bishopsgate. The installation there has been carried out entirely with our concentric wiring, and to meet the requirements of the City supply an even ratio transformer has been put on, dividing electrically our wiring from the supply company's mains. Between the meter and the transformer is a distance of about 112 feet, and two leads are used to connect between these points. As they were iron-armoured leads, the armouring was used merely as a protection, and an experiment was made to see the effect of iron armouring that did *not* carry any current upon the insulated cable carrying the current. The reason of the experiment was to see if laminating the iron enclosing the conductor reduced the inductive effect beyond the point found with the ordinary street iron pipe; and although it certainly did in a small manner, yet running no return current in the armouring itself, there was a certain amount of self-induction in the cable.

Recent experiments, however, tend to show that where a concentric wire consists of iron or copper, the self-induction is practically the same, *i.e.*, provided each conductor is carrying current, and if an ordinary copper concentric cable is used in place of the iron armour, section for section, the results are the same in every case.

As this is a matter that we have carefully gone into, and one, if left undenied, might prejudice the adoption of our wiring for alternating currents, we shall be glad if you will give this letter prominence in your next issue, and we hope in a short time to be able to publish an exhaustive series of experiments showing that whether a concentric cable has its different conductors insulated or uninsulated, or whether some of them are made of iron and others of copper, the loss due to induction is the same, provided all conditions are alike.

J. D. F. Andrews & Co.

THE BOARD OF TRADE INQUIRY INTO THE CITY ACCIDENT.

The Board of Trade inquiry into the accident in the City was resumed last Friday before Major Cardew.

Mr. Chesterman, M.R.C.V.S., said he made a *post mortem* examination on the evening of the 10th inst., on a bay mare which had been killed in the accident, by request of Mr. Boutland, the owner of the animal. He found nothing which would account for its death. All internal organs were perfectly healthy; there was no appearance of congestion, and no wounds. The legs were drawn up in a peculiar way and stiff; the body was not specially stiff. He did not think the horse was suffocated. He saw nothing to indicate the passage of a current through the body, except that the anus was drawn in. The bleeding from the nostrils was due to the fall. The age of the mare was about six years. He could not have accounted for death unless he had been informed of the cause. He had never had occasion to examine a horse under similar conditions. The blood was not discoloured more than usual; it was, however, a little clotted in the ventricles of the heart. He had attended Mr. Boutland's stables for years, but had never had this particular horse under his notice.

By Mr. Griffiths: He did not open the forelegs of the horse, and did not know the state of the tissue there. He had never examined into the death of a horse by lightning.

By Mr. Wallace: He had never heard of the death of an animal in London from electric shock.

H. Smith, foreman of cable laying for the City of London Company, said he superintended, on October 11th, the laying of the main from Watling Street station. The pipes were already on, and they had only to draw in the mains. The main was laid in lengths, connected together at junction boxes. He was not present when the connections were made. It was the duty of another foreman to see these connections made. There were probably 15 lengths between Watling Street and Bankside. Each length was labelled at each end, Watling Street main.

By Mr. Griffiths: He superintended the laying of the main from Milk Street to Bankside, which was begun on the 9th. It took nearly a week to get each main through. The Milk Street main would be in about 18 lengths. It was laid in the same way as the Watling Street main, and labelled. It was his duty to see that the mains were labelled. He was satisfied that the labels were properly attached. The mains were laid in the proper racks at Bankside, the ends being ready to be put in the switch pillars.

By Mr. Wallace: The labels were fastened to the ends of the cables by iron wire. Men going into the junction boxes might tear them off. The labels were of linen and paper. He noticed at places that the tubes were crossed. The Witness pointed out to Major Cardew on the map the places where they crossed. One place was opposite the Edison-Swan Company's premises, Queen Street. They could not very well avoid crossing. The two cables were drawn in at different dates, and labelled at each end as soon as they were drawn in.

William Parrott, jointing foreman to the City of London Company, said he superintended the jointing up of the Watling Street main. The work was finished about November 7th. Each main was labelled, and was joined up according to the label. He personally saw that the labels were in position before the jointer went into the box. The labels were still on them. He examined the cables after they were jointed. Since the accident occurred he had traced the cable right through, and had found that the Watling Street cable was crossed with the Milk Street one between the Edison-Swan box and Maiden Lane. The cables had now been correctly connected. He superintended the jointing up of the Milk Street cable, which was labelled. The only way in which he could account for the wrong connection was that the wrong labels had been attached. The alteration in the connection had been at Bankside. In consequence of the crossing of the pipes, the mistake had been made in the labelling. He traced out the cables on the day after the accident, the 11th inst. The first examination of the labels after the accident took place on the same day. None of the men who assisted him on that day were from the main laying department. He was positive the connections were made in accordance with the labels. He did not go down into any of the boxes, but could see from the top of the box the writing on the labels. The second engineer of the company, Mr. Bates, on the 13th, asked where the cross was, and went with him to the boxes at Edison and Swan premises and the corner of Thames Street, where the joints are made; the piece of cable at Edison-Swan, labelled Watling Street, was labelled Milk Street in the other.

By Mr. Wallace: He differed from the last witness in his evidence as to wrong labelling.

By Major Cardew: He took his orders from Mr. Alex. Cook, the superintendent.

Mr. Alexander Cook, superintendent of cable laying and transformer stations, said he gave orders for the laying of the Milk Street and Watling Street mains. Part of the way they were drawn in at the same time; this part is where the crossing occurred. He did not test these mains, nor personally examine the labelling, before the jointing was done. The reasons of delay in laying the cables was the cable was not ready, and the box at Thames Street was being enlarged. He ordered the examination of the mains to be made on the Sunday, the 11th, and saw the boxes at Maiden Lane and opposite Edison-Swan premises opened. He could not speak to the labelling. He did not make any electrical test, but took the word of the testing department that the cable was correct. Parrott, whose duty it was to connect the cable to the switch pillar, was also informed that the cable was right. He had been engaged in electrical work for 12 years, and would know how to test a cable for continuity. He should say that was the first test to be made. Such a test would have revealed the existence of the fault. He was not present at the Watling Station when pressure was switched on to the new main. He considered switching on to a new main rather an important operation. He was prevented from being present by having to attend to the payment of men elsewhere. He was not aware of the exact time the main was to be made alive. It was the intention to make it alive early in the morning, but they were not quite ready at the Bankside Station. The foreman at Watling Station was informed that when he received a signal from Bankside he had to switch the main in. The arrangements for switching in were the same as usual. There was a fuse, but it was rather a heavy one, being able to take 450 ampères. He did not think such a large fuse necessary, as the current would be very small; a fine wire fuse would have been sufficient. There were periodical tests of the insulation of the system, made under his direction. The tests between outer and earth came out fairly high. He examined the piece of main which broke down at Budge Row and found the fault developed close to the end of the pipe. The edges of the pipe were fairly smooth. The main was bent at that point, but the angle was not very sharp. They had had no previous faults on these India-rubber mains.

By Mr. Griffiths: They did not make any visual examination of the insulation of the cables at junction boxes periodically. He thought that when rubber cables passed through junction boxes they might become abraided. Mr. Griffiths asking the date of the last test before the accident, it was stated that it was on November 2nd.

Mr. A. Cook: The actual current passed through the fuse when the cable was made alive was about 15 amperes, and the fuse would be no protection. The new main was required to replace Pancras Lane main, which had to be cut out of circuit on account of alterations at Bankside It was the intention to cut out the Pancras Lane main on the afternoon. The load was not heavy on Saturday night. The alterations at Bankside could be made more conveniently on Saturday and Sunday. It was the duty of the foreman of the testing department to see the cable in proper order before it was put on. It was his duty to report to him (witness) the result of the test, also to report to Mr. Parrott, before he put it into the switch pillar. A written report would have been

sent to him under ordinary conditions in a few days, but as time pressed they received the message by telephone. He asked the foreman of the testing department if he had tested the Watling Street main? he said he had made a rough test. He asked the witness if it was good enough to put on. The reply was yes. Parrott received a note from the testing department. This note was produced by the witness. The note was read; it was one from Parrott to Mr. Peard, which asked "could Watling Street main be put into pillar—wanted to be at work by 11 a.m." The reply, in Mr. Peard's writing, was to the effect that "cable is good, but the final test has not yet been taken; can go into pillar." Mr. Cook, continuing, said: No examination was made of the Milk Street and Watling Street mains by the cable laying department by his orders. The examination on the 13th inst. was made by Mr. Bates, the distributing engineer.

Mr. Oliver Peard, in charge of the testing department of the City of London Company, said the method of testing was as follows: First of all, a printed notification from the cable jointing department was sent to him that cable was ready. A similar form was handed in by witness to Major Cardew. It was his duty to hand back the form, duly signed, when the cable was ready for work. It was a certificate that the main was all right. Until he returned the certificate signed he did not hold himself responsible. This was well understood, and had never been altered. If the main was wanted in a hurry, he was informed, and he made a rough test of the insulation to detect any fault. The cable was then put into the terminal switch pillar and the transformer before it was finally tested. The meaning of his words, "can go in pillar," was simply that the cable was ready for the final test, but was not to be made alive. After the main is put in the pillar terminals, a careful insulation test is made, which is recorded. The cable is identified between the two insulation tests by putting a galvanometer at each end, which is observed by a man. The Bankside end has a battery attached; the first thing is to put the inner conductor to earth at both ends through the galvanometers, and the deflections noted. After these the galvanometers and batteries are placed in circuit between the inner and outer, and the deflections noted. The switch pillar was so arranged that this could be carried out; this test was made with the cable ends in their proper terminals. After the accurate insulation test a pressure test is made. As a rule the pressure would be put on from Bankside, except in the case of inter-connecting mains. For these particular high tensions a pressure of 10,000 volts between inner and outer, and 5,000 between outer and lead would be used. To his knowledge, no pressure tests had been made on the rubber cable from October, 1892, to the date of the accident. There were probably about six or seven rubber cables. He could not say what the rubber cables would stand from outer to earth. He knew, however, that a pressure of 2,000 had been put on the outer conductor of the system, owing to the earthing of the inner pole at the Coleman Street transformer station, but the current was not sufficient to blow a 45-ampère fuse. The fault was on for a few minutes. This occurred about six weeks ago. Another insulation test is taken after the pressure has been applied, and they generally got an improvement. They kept the pressure on for about 15 minutes; never less than 10. The electrostatic capacity and copper resistance are then taken. The tests occupy an uncertain period, never less than two days. During this period the main is not used. These tests were only for new cables. A temporary test of Watling Street cable showed fair insulation. He understood from Parrott's note that it was required to charge the cable. Mr. A. Cook had a written report made by the witness as soon as possible. When Mr. Cook telephoned, he told him that he (witness) had made a rough insulation test, and that it was fairly good. Mr. Cook then said all right, and he heard the click of the telephone being replaced. Mr. Cook did not ask him if the main could be put on. Mr. Cook's "all right" did not signify to him that the cable was going to be put to work, after receiving his message. He was not present when the cable was put to work. He had no recollection of any cable being put to work before without the full tests being made. The witness then handed in an extract from the record of tests (periodical) of Benetfink main. There had not, to his knowledge, been any previous fault on the main.

By Mr. Griffiths: The voucher would show that the whole series of tests had been carried out. He thought before a cable was used all the tests detailed should be made. In the usual course of affairs Mr. Cook would hear nothing about it until the complete series of tests had been made. There had been no recorded test when the main was made alive.

By Major Cardew: Mr. Cook's question did convey that he wanted to use the cable, but when he told him that he had only taken a rough insulation test, it never occurred to him that it would be used. No cable ought to be used until it was identified.

Mr. Joseph MacMahon, foreman of the transformer department, said he switched on the pressure to the new main at Watling Street Station on the 10th inst. This was by order of Mr. Cook by telephone, which was to the effect that he was to proceed to Watling Street Station and wait for word from Bankside to switch on. He received a written note from Mr. Parrott, sent from Bankside, that he was to switch on; he did so immediately. He noticed after a minute or two a kick in the lights, so immediately switched out. There was no unusual spark. He had no voltmeter under observation at the time. Both interconnecting mains which feed this station were in circuit.

By Mr. Griffiths: There was no high tension voltmeter at the transformer station; there were some at Bankside, which was the proper place to make observations.

By Major Cardew: He agreed that the fuse would have taken 450 to 500 ampères.

Mr. J. P. Buck, superintendent of conduits, said he had found it necessary to cross the pipes occasionally, where obstacles were met. He did not lay the conduits in Queen Street. He saw both boxes in Budge Row and Walbrook about half an hour after the accident. The top of the box in Budge Row was off, and he should say there had been an electric arc; the insulation appeared to be burnt off the cable; the low tension cables appeared to be all right. He did not notice much signs of fire nor electric arc in the Walbrook box. Up to the time of the accident they had two men going round periodically to inspect the street boxes for gas. They commenced on January 10th, 1894. The men had no special orders, but thought if they noticed anything unusual they would report it. The witness handed in a report showing the number of times the boxes were visited, which appeared to be at intervals of about 40 days. The operation might be quickened if they used gas detectors. If gas were found in a box he should report to the secretary, who would send to the gas company; the gas company generally sent to attend to the leakage. The iron pipes in which mains are laid are jointed with red lead, and not with metal.

By Mr. Griffiths: There were seven pipes entering Budge Row, two of which were occupied; that was the same all round the system. Gas could easily travel from box to box through the pipes. The company have been increasing the size of the boxes by a foot or two either way. They had enlarged about 12; there were about 4,000 boxes. He thought the larger ones were more dangerous than the smaller ones, *i.e.*, if there were any danger at all. He had received no orders to continue the work of enlarging. They had never used plugs to ends of pipes since August, 1891. He thought no pipes could be plugged, and the bitumen conduit could be plugged with bitumen.

By Mr. Wallace: If they were ventilating the mains, plugging would interfere with the arrangement. He did not think that gas came along the pipes, but leaked into the boxes. He had never found broken pipes; they were made of wrought-iron.

Mr. F. H. Jackson, engineer in charge of generating stations, said that he was at Bankside on the 10th. At the moment of the accident he was at the telephone, and heard the disturbance caused by the telephone. Mr. Ferguson told him that there was an arc in the new switch-room. He went, and saw the arc at the back of the switch pillars; a tracing was handed in which showed the position of cables at the time of the accident. He ran down to the telephone to tell them to switch off, but found Mr. Parrott there, telling them to switch off. The arc, he thought, was going for about five minutes, but not much longer, as they had the light on in 13 minutes. There were four machines running, one 500 units, one 250, one 350, and a 350 machine with half-power engines. Two were Brush and two Thomson-Houston machines. The Brush machines were switched off as soon as the short occurred. The lights went right out. He looked at the ampèremeters of the Thomson-Houston machines, which were hard over, the maximum being 200 and 150. About 190 ampères should have been going out, which was the load just before. The Thomson-Houston machines were running for two minutes longer. They determined to switch out the circuits to find the faulty one, because it continued, although the Watling Station cable had been cut out. When the Benetfink and Pancras Lane switches opened the lamps lit up. There was a short circuit on the Benetfink main. He had seen one of their main fuses go. The Bates fuse, which goes quietly, went about the right current. With a large fuse only one-third of the current in Mr. Preece's tables was required. It took a little time. The potential from outer to earth was not continuously indicated, but was measured occasionally; it had never exceeded 200 volts under ordinary conditions. If it did, he should expect a fault. He thought this pressure should be continuously recorded.

The enquiry then terminated.

NOTES ON LAUNCHING.

A paper recently read before one of the American societies by Wm. J. Baxter, naval constructor in the United States Navy, shows the practical details of two successful launches in a narrow river. One of the vessels, the *Texas*, a twin screw second class battle ship, with fine ends and broad beam, was launched at the Norfolk Navy Yard on June 28th, 1892. The author gives the following particulars regarding the launching operations of this vessel:—

An apparatus for automatically registering the velocities during the launching of the vessels was improvised and used with gratifying results. If one end of a long length of wire, which is wound on a drum, be wound once around a freely revolving wheel, and then attached to a ship or other moving object, the wheel will be rotated. Knowing the number of revolutions occurring during a known time of this pulley, whose circumference is known, the exact distance the ship travels during this time can be accurately determined if the line be kept continually taut between the pulley and ship; also, if each revolution of the pulley be accurately timed, the exact position of the vessel at each instant will be known, and, knowing this, the velocity, acceleration, and coefficient of friction can be determined. The apparatus used to accomplish this was as follows:—

On a heavy piece of timber two rigid bearings were securely fastened; one carried a pulley ordinarily used for wire rope transmission, which had been accurately balanced and turned; the other bearing carried a strong balanced wooden drum, on which was coiled a steel piano wire, No. 16, 1,000 feet long. On one side of this drum was a groove, over which passed a manilla rope, which acted as a friction brake, being weighted by a keg containing water. The wire being wound once around the drum, the brake was adjusted so that there was no perceptible sag in the wire, and as an additional precaution, a water tank was arranged to gradually fill the keg, thus increasing the tension of the wire, and ensuring that it was continually taut from start to finish.

The revolutions were timed by the Weaver electric speed register. This ingenious instrument was designed to carry into effect Engineer-

in-Chief Melville's method of making speed trials by registering the number of revolutions of the screw shafts. It is a chronograph fitted with five pens, electrically controlled, having a piano action. When the corresponding circuit is completed, a pen makes a dash on a paper tape which is moved by a clock train with extreme uniformity. The central or time pen is connected with a chronometer and marks each second; the revolution pen on each side marks each revolution of the port and starboard shafts; while the outer or range pens mark simultaneously the instants of beginning and ending the measured mile run, permitting a datum line to be drawn across the tape, from which are measured the fractional parts of time and revolution.

The register was adapted to the present experiment by fitting a make-circuit attachment to the axle of the wire rope pulley, and connecting it to a revolution pen; the range pen was connected to a portable button in the hands of an observer; while the time pen was connected to a break-circuit chronometer and relay. The register and two sets of drums and pulleys were placed underneath the launching platform at the bow. When the men began sawing off the sole piece, the observer signalled to an assistant, who threw on the circuit and started the register; the time pen began marking at once, and, as the ship moved, the revolution pens began marking, all three acting automatically until the finish. The observer, with the range pens, noted the time of starting, letting go the anchor, pivoting, stoppers breaking, and hawsers tautened, &c.

With the *Texas* both lines were attached to the ship, as a measure of special precaution; one snapped after the ship had travelled a short distance, but the other registered continually until the ship stopped.

LEGAL.

Shelfer *v.* City of London Electric Lighting Company. Meux's Brewery Company *v.* the same.

Two appeals from the decision of Mr. Justice Kekewich, of April 19th, were opened on Friday, and continued on Monday, the 26th inst., before Lord Halsbury and Lords Justices Lindley and Smith. In the Court below Mr. Justice Kekewich refused to grant an injunction restraining the City of London Electric Lighting Company from working their dynamos in such a manner as to cause a nuisance, and injure the plaintiffs' premises by vibration; but he referred the whole question as one for damages to the official referee. Against that order the plaintiffs appealed. The first plaintiff, Mr. Shelfer, is the tenant of the Waterman's Arms, Bankside, Southwark, and the second plaintiffs, Messrs. Meux & Co., are the owners of the premises. The action was brought to restrain the defendants, their workmen, agents, &c., from working their machinery in adjoining premises so as to cause nuisance and damage arising from steam, noise, and vibration.

Mr. Warmington, Q.C. (Mr. Badcock with him) submitted that the case made out could only be met by an injunction. The noise and vibration not only deprived the occupants of the Waterman's Arms of sleep, but caused loss of custom to the house, and therefore it would be impossible to assess prospective damages; nor could prospective damages be given to Messrs. Meux for structural injuries, especially as the machinery now working at 4,000 horse-power might (probably would) be increased to 20,000 horse-power. The injury was not temporary but permanent. He submitted that in such a case, under Lord Cairns's Act (providing for damages instead of an injunction), the Court had no discretion; and if the plaintiff proved that he was entitled to relief, then he was entitled to an injunction. The tenant was entitled to an injunction when he showed that the injury was of such a character as would last during the period of his tenancy, and the Court could not compel the owner of the property to stand by and see his property destroyed.

Mr. Fletcher Moulton, Q.C. (Mr. Renshaw, Q.C., and Mr. Braithwaite with him) contended that, as the defendant company were working under their statutory powers, all that the plaintiffs were entitled to was damages arising from loss of trade, structural injury, &c. An inquiry as to damages was all that the plaintiffs were entitled to, and that Mr. Justice Kekewich gave them.

At the conclusion of the arguments, their Lordships took time to consider their decision.

The Electrical Power Storage Company *v.* The Chloride Electrical Storage Syndicate.

In the Chancery Division of the High Court of Justice, on Friday, the 23rd inst., this matter came before Mr. Justice North.

Sir Richard Webster, Q.C., said he had a motion in this action for an injunction to restrain the breach of what he might call the great patent for secondary batteries. The plaintiffs' patent expired in May of next year, and, therefore, time was of the essence of the matter. Having regard to the fact that the evidence was not completed, he was not in a position to move the motion, but he was desirous that it should be effective for the following week, and for that purpose he asked that the defendants should undertake to file any evidence they desired to use by Tuesday next.

Mr. Justice North pointed out that the following week his motions would be taken by Mr. Justice Chitty, and consequently they would be heard on the Thursday, instead of Friday.

Sir R. Webster said that this was another example of the inconvenience of shifting motions from one court to another, and he hoped the time was not far distant when the old state of things would be reverted to.

Ultimately it was arranged that the motion should stand over until Thursday, December 6th.

BUSINESS NOTICES, &c.

Universal Electrical Directory (J. A. Berly's).—Messrs. H. Alabaster, Gatehouse & Co. have now in course of preparation the 1895 edition of this directory, which embraces all connected with the electrical trades throughout the Universe. It is indispensable to everyone having business transactions in the electrical world. Names and addresses for insertion, corrections, and orders for advertisements should be promptly forwarded.

Arbroath.—The Gas Corporation have written to the Electric Supply Company, Limited, acquainting them with their intention to oppose their proposed application for a provisional order enabling them to supply the electric light in the burgh.

Ayr.—The Council on Monday resolved to acquire a site for the electric light works, and to empower a committee to conclude the purchase.

Brentford.—A Mr. Sarbury, of London Wall, having written asking upon what terms the Local Board would grant a concession for the electric lighting of the district, the board have decided that sufficient details were not before them at present to enable them to come to a decision.

Bournemouth.—The electric light is now laid on at the Wesleyan Church.

Cardiff.—A special meeting of the Lighting and Electrical Committee of the Cardiff Corporation was held last week for the purpose of making a primary selection of candidates for the post of electrical foreman at the Cardiff Electric Lighting Works. The candidates selected to appear before the committee were Philip Peters, St. John's, Worcester; Thomas J. Archer, Chelmsford; and Charles H. Yeaman, Victoria Street, Westminster.

Messrs. Leaf & Co. are now installing the electric light into the new Aberdare Hall.

Chiswick.—In further reference to the electric lighting affairs here, Messrs. Bourne & Grant now write to us as follows:—"We have read your remarks in this week's Review in reference to the letter which we sent you. What we wish to complain of, and what we now complain of, is that the statements you published explained nothing and left it open for your readers to take an incorrect, and, as far as we are concerned, unfavourable view of the matter. If you had originally published the statement you now publish, we should not have had to complain of unfair treatment at your hands, but we should have pointed out, as we do now, that even the statement would create an incorrect impression and we shall be glad if you will, by publishing this letter, help to remove it. It would appear from that statement that we had started work without submitting plans; and the member of the Board who asked that we should submit plans was evidently ignorant of the fact that we had done so as far back as June 6th last, showing exactly the ground which we required. Nothing has been wanting, therefore, on our part to facilitate the progress of the work, and the Chiswick Local Board or the Committee, has certainly no cause to be dissatisfied with us, and, as a matter of fact, we have not received from them any letter expressing their dissatisfaction. You may allow us to add that we stopped the works on October 25th, in consequence of the Chiswick Local Board refusing to allow us to enclose ground shown in the plans submitted four months and a half previously, which plans we had been led to believe they approved. The matter, we think, has now been arranged and we shall proceed."

Clifton.—Messrs. Crompton & Co. are carrying out an installation of 64 16-C.P. incandescent lamps in the big school of the Clifton College, Clifton, in addition to which they are wiring the headmaster's and two of the other houses connected with the College. The whole of the work is being superintended by Mr. Herbert T. Sully, of Bristol, who is acting as Messrs. Crompton's local agent.

Coventry.—At the Council's last meeting the General Works Committee presented a report with reference to the tramways. Two years have elapsed since the trams were running, and it has been proposed by Mr. Graff Baker, on behalf of the owners, that they should be equipped with electricity. The council have agreed to this, but now that no work has yet been done it was decided at this meeting to give the company three months' notice to terminate the agreement between them and the corporation.

Dewsbury.—A monthly meeting of the Dewsbury and District Infirmary authorities took place last week. The secretary was recently instructed to write to the town clerk to ascertain whether the Corporation propose to bring the electric light to the neighbourhood of the Infirmary, and, if so, what would be the probable cost of lighting the institution. In moving the adoption of the minutes, it was said that there had been no reply from the Corporation respecting the supply of electric light to the institution.

Dover.—The Buckland Vestry has decided to light the parish church by electricity, and the Dover Electric Supply Company's mains are being laid for that purpose.

Dundee.—At a recent meeting of the Gas Committee, an application was submitted from Messrs. Jaffe Brothers, jute merchants, to have their establishment in Seagate illuminated with electric light. The engineer reported that the mains would require to be extended in Seagate to give effect to the request, and this he estimated would involve an expenditure of £135. It was agreed that the request should be granted.

Offers for engine seats at the central station have been submitted, and that by Mr. A. M'Ritchie, amounting to £81 13s. 8d., has been

accepted. The convener and electrical engineer were instructed to procure meters for use in connection with the station. It was reported that steam piping was required for the new engine erected at the station, and a remit was made to the convener and the engineer to arrange for obtaining the same from Messrs. Whyte and Cooper, Dundee.

Edinburgh.—At the Council's last meeting, Messrs. Mackenzie and Cranston gave notice of the following motion "to remit to consider and report as to whether it is desirable at this stage to arrange for laying down electric light high tension cables from the station to Nicolson Street for the purpose of supplying domestic lighting through transformers."

The Electric Light Committee of the Edinburgh Town Council has agreed to supply electric current for the lighting of the M'Ewan Hall and the Medical School, New University, and also to give a supply to large business premises, called the Globe Mart, at the top of the Canongate. These buildings are outside the compulsory area.

The contract for the lighting of New Craig House, Morningside, Edinburgh, for the managers of the Royal Edinburgh Asylum for the Insane, have now been completed by Messrs. Ernest Scott and Mountain, Limited. The installation consists of two Lancashire boilers, each 25 feet long by 7 feet 6 inches diameter; four compound horizontal engines, each capable of developing 60 effective H.P., with the necessary steam pipes, including feed-water heater and feed pumps; four "Tyne" compound wound dynamos, each capable of feeding 400 16-C.P. lamps; with the necessary main switchboards and coupling switches, and about 1,350 16-CP. incandescent lamps and fittings.

Folkestone.—A private installation of electric light has been carried out at Mr. Carlo Maestrani's dining saloon. Mr. Webster carried out the work.

Halifax.—Mr. Wilmshurst, the borough electrical engineer, states that within about a fortnight, it is hoped there will be turned on current for the whole of the mains laid. There are about 100 customers for the light, representing nearly 2,500 lamps. The formal opening of the works may possibly take place in January.

Harrow.—The Governors of Harrow School have intimated to the Harrow Local Board their willingness to favourably consider a proposal for lighting the school chapel, library, and other school buildings, providing they had full estimate of the cost. The Board's engineer offered to estimate at 5 per cent if the work was carried out, and 2½ per cent. if it was not carried out. The headmaster of the school would not pledge himself to this expense, so the Board decided to ask ten good firms for tenders. Eight were were sent in, and the committee having charge of the matter sent up two of those tenders to the Board for consideration. These were from the Brush Company and from Messrs. Crompton. The Board accepted Messrs. Crompton's provisionally, and it was announced it amounted to £8,762 for plant, &c., and £1,686 for maintenance, as against the engineer's estimate of £9,300 and £2,092. The Board expressed themselves as exceedingly satisfied, the estimate of the accepted firm being so close to that of their electrical engineer.

Keswick.—A local paper describes in the following manner the freaks of the electric light at Keswick:—"'Sista, here's anudder yan coming; keep quiet noo! divvent let on. Ha, ha! sec a jump.' These were the remarks in a Cumbrian crowd gathered in Keswick Main Street a few evenings ago. Something had gone wrong with the electric light wires, and the current was descending an iron spout and crossing the footpath by an iron gutter. Passengers who happened to step upon it received a galvanic shock, and their gyrations were the occasion of considerable amusement. The victims having emerged from the ordeal stood by to await fresh arrivals. The ladies made the biggest outcry, but undoubtedly the men performed the wonderful feats. The current was so strong that one youth had to lay down to roll out of the way."

Kingswood.—At the last meeting of the Local Board the question of the better lighting of the district came up for consideration, but nothing was decided in regard thereto.

Some days ago the Chairman of the Board said that at the beginning of the year the extension of the electric lighting will have to be considered.

Limerick.—The premises of Messrs J. and G. Boyd, which were destroyed by fire some fifteen months ago, have just been rebuilt. For the lighting of the premises electricity is generated by dynamo worked by a Crossley gas engine of 20-brake H.P. The electrical appliances were fitted by Mr. Normon Robinson, electrical engineer, Dublin. The engine, while working the dynamo, is also used in connection with a lift, erected by Messrs. Waygood & Co.

London.—At the meeting of the St. Luke's Vestry, last week, a letter was read from the Board of Trade, which set forth that there was a difference of opinion between the London County Council, the electric lighting companies, and the Vestries with regard to the laying of the "transformer" chambers for electric lighting in the public streets. It also suggested that the Vestry send a deputation to a conference on the subject. The chairman of the Works Committee and the surveyor were appointed to attend.

Messrs. Rashleigh Phipps & Co. have received the contract for the electric lighting of Mr. Frank Wyatt's new house in Queen's Gardens, and also for Mr. J. A. Michell's new restaurant in Prince's Street, and the offices of the National Assurance Company of Ireland, in Nicholas Lane. They have also just completed the lighting of the Wimpole Hotel, Wimpole Street, and Limmer's Hotel, George Street, Hanover Square, and are very busy with electric lighting several private houses, &c., in the West End.

Newcastle.—Tenders are shortly to be advertised for for lighting the workhouse by electricity. A report by Mr. Parsons estimates that the guardians will save at least £130 annually by having the electric light. The first cost of the installation will be about £1,200 to £1,500.

The City Lighting Committee has decided to put up a 1,500 C.P. electric lamp at the foot of Picton Place, lighting the entrance to the Blyth Station, and another lamp of the same power near the east end of Byker Bridge.

Nottingham.—On Thursday, last week, the Corporation supply was switched on to the four large arc lamps which have been erected in the Market Place by Messrs. Johnson & Phillips. The lamps, which have been placed respectively in front of the Exchange Hall, at the end of the new road across the top of the Market Place, are of 4,000 C.P.

Prescot.—There has been some correspondence passing between a Mr. J. D. Banks and the Local Board regarding the "interruptions" of the electric lighting, effected by the British Insulated Wire Company. Mr. Banks has stated it as his intention to make a representation to the Board of Trade, unless some improvement is made; but the Local Board, in reply, have stated that they doubt if he will be able to prove that the company has incurred any penalty, as Mr. Banks asserts, or "have made default in supplying electrical energy."

Radcliffe.—The Local Board intend charging 8d. per Board of Trade unit.

Rhondda.—At the last fortnightly meeting of the Local Board the Clerk read letters he had received from various colliery companies in respect to the proposed scheme to light the valleys by electricity. Messrs. Cory Brothers, Cardiff, stated they had no supply of electricity to spare at the Gelli Colliery, but at the Pentre Collieries they could afford to supply the Board with 50-candle-power lights. As they were not accustomed to supply electricity to outsiders it would be difficult for them to furnish terms. The company were prepared to give further consideration to the scheme. If the Sanitary Authority would grant a licence for supplying the district generally, the company might be disposed to consider a scheme for laying down an additional installation to light the streets as well as the houses. Messrs. D. Davis & Sons, Ferndale, replied that they would give the scheme their consideration, and would forward their views to the Board in a few days. The Glamorgan Coal Company, Llwynypia, inquired whether the Sanitary Authority desired them to lay down cables, and what number of lights were necessary. After receiving full particulars of the scheme the company would be able to give a definite reply.

Stanton.—With regard to the question of lighting Stanton, it is stated that there is a probability of being able to arrange for lighting it from the Stanton Lane colliery with electric light, and a deputation from the committee has been appointed to meet Mr. Johnson (the manager) on the matter. The tenders for 12 new lamps and pillars, as ordered at the last meeting, have been obtained, and, upon the recommendation of the committee, Mr. H. Harvey's at £25 10s., was accepted.

Sunderland.—At the last sitting of the Highways Committee it was decided to insure the boilers at the electric lighting station for £6 7s. 6d. a year, this covering a risk of £4,500, including employers' liability. It was decided to lay 20 meters in stock for supply to customers. They will be of various sizes, and are estimated to cost altogether £118 9s. A number of fuse boxes are also to be laid in stock, to cost £18 13s. each.

A meeting of the Town Hall Committee was held last Friday to further consider tenders for the necessary fittings and alterations for the electric lighting of the building. There were 16 tenders for the laying of wires, and the prices asked ranged from £800 down to £310. On the opinion of the electrical engineer being taken it was decided to accept the lowest tender, that of Messrs. Reed, Ferens & Co., of the Borough Road, Sunderland. The tender of Messrs. Crompton and Company, for the alterations to the existing gas fittings was accepted, the price being £35. Other expenditure was also decided on as follows:—Two arc lamps for the front of the building, £15 8s.; two pillars estimated £25, mason and joiner work estimated £40; fixing and contingencies estimated £25; bringing the total cost up to £450, against the original estimate of the electrical engineer, which was £595. A further special meeting will be held to select designs for the arc lamps and pillars.

Wantage.—Messrs. Robinson & Auden, Limited, have just put an electric light installation into their works at Wantage, Berks. The engine is one of their high speed verticals, specially designed for dynamo driving, and the dynamo is by Newton, of Taunton. The fitting, erecting, machine, and wood working departments, foundry, and offices have all been lighted. The firm's own staff did the whole of the work, and the installation has worked with perfect success from the moment the lights were first switched on. The firm are making a speciality of vertical engines for dynamo driving.

Wishaw, N.B.—A provisional order for electric lighting is to be applied for by the Commissioners. A report was made by Mr. Mavor.

Woolwich.—The London County Council has given its sanction to the Woolwich District Electric Light Company to lay mains across Powis Street and in Eleanor Road.

Worcester.—A local paper says that the electric light has undoubtedly "caught on" in Worcester. The demand from private consumers is constantly necessitating extensions of the mains in all

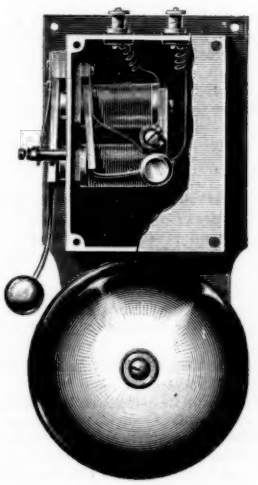
parts of the city. Since the inauguration of the light on October 11th, over 1,000 8-candle-power lamps have been supplied.

A special committee has been appointed to look after the electric lighting affairs of the town.

Agency.—The Unbreakable Pulley and Mill Gearing Company, Limited, Hyde Road Engineering Works, West Gorton, Manchester, have appointed Messrs. Fletcher, Hirst & Co., Bankfield Works, Burnley, as their agents for the sale of their unbreakable pulleys, bright steel shafting, adjustable and swivel bearings, and "Gorton" patent gas engines.

Association of Municipal Corporations and the Telephone.—At a meeting of the Council of the Association of Municipal Corporations held at the Westminster Palace Hotel, on Thursday, last week (Sir Albert Rollit, M.P., in the chair), the following resolution was passed:—"That in the opinion of the council no powers should be given to any telephone company which will enable them to interfere with streets, or with the rights of individuals in property, unless statutory conditions and obligations are at the same time imposed on the company for the protection of the public, particularly with regard to maximum charges, maximum dividends, and obligations to supply; that the subject should be treated as an imperial, and not as a local one; and, therefore, it should be urged on Parliament that so much of the draft agreement between the Postmaster-General and the telephone companies as relates to vesting in the companies the wayleave powers of the Postmaster-General under the Telegraph Acts should not be carried out. That this resolution be referred to the special committee on the subject, with authority for them to arrange for a deputation to the Postmaster-General."

A Watertight Electric Bell.—The accompanying illustration shows a new form of electric bell recently designed by Mr. F. C. Allsop. It has been designed for use in mines, railway stations, on board ship, and all other places where bells are exposed to damp, and the direct action of the weather. The chief feature of the invention is that the magnet coils, contact breaker, and all other parts liable to be affected by moisture, &c., are hermetically sealed in a metal box, so that the bell may be fixed outdoors in all weathers. In fact the bell will work under water, and may be left submerged for months together, without in any way affecting its working. The illustration is of a 6-inch bell. Both the base and the box are of metal, and cast in one piece, the box being fitted with a metal lid, and a layer of India-rubber being used to make it watertight. Inside



the box are the magnets, the poles of which pass through one side, while outside the box, and opposite these poles, are the usual armature and hammer working on the gong below. Inside the box polar extensions are fitted to the magnets, and off these extensions is worked a second armature fitted with a contact breaker. Thus the armature inside the box makes and breaks the circuit, causing the one outside to vibrate in union with it. Contrary to what might perhaps have been expected, these bells give a very powerful stroke, and do not require any more battery power than the ordinary form. The bells are being manufactured and placed on the market by Messrs. F. C. Allsop & Co., of Queen Victoria Street.

Bannister v. Sax & Co.—M. C. Bannister, civil engineer, Liverpool, sought at Liverpool to recover from Julius Sax & Co., Limited, electrical engineers, Smithfield Market, London, £365 for out-of-pocket expenses and professional services rendered in connection with the preparation of plans for cold storage accommodation to be added to the defendants' premises in Smithfield Market. The defendants repudiated the claim, alleging that it was not on their account that the work had been undertaken. After the case had proceeded some considerable length, the parties agreed upon terms.

"Cassell's Family Magazine."—We have received a copy of the first part of a new series of this magazine, which is as interesting as any of the similar monthlies, and as well prepared.

Dissolutions of Partnerships.—Notice is given in the *London Gazette* that the partnership heretofore subsisting between H. T. Middleton, J. F. Nugent, F. B. Spencer, and E. C. Wild, carrying on business as electrical engineers and contractors at 34, Victoria Street, London, S.W., under the style or firm of H. T. Middleton & Co., has been dissolved by mutual consent as and from the 15th day of November, 1894.

Also that the partnership formerly subsisting between W. W. Judd and J. S. Haswell, under the firm of Judd & Haswell, at the Watling Street Works, Leicester, in the trade or business of electrical and general engineers, was dissolved by mutual consent on November 17th.

Also that the partnership heretofore subsisting between G. S. Tunks and E. R. Polehampton, carrying on business as mechanical and electric engineers and oven builders, at 3, Mill Lane, Cardiff, under the style or firm of Tunks & Co., has been dissolved by mutual consent as and from the 15th day of November, 1894. All debts due to, and owing by, the said late firm will be received and paid by the said Gilbert Samuel Tunks.

Electrical Organ Blowing.—At St. Paul's Church, Prince's Park, Liverpool, the organ is now blown by electricity.

Electrical Pumping Plant.—Electrical pumping plant, consisting of a Corliss type engine driving on to a dynamo giving an output of 50 units, has just been erected at Cambois Colliery, owned by the Cowpen Coal Company, Limited. The pumping in the mine at Cambois was originally done by the hauling engine driving the endless wire rope, the rope passing over the pulleys of these pumps underground and driving them, the pumps being 8 inches diameter and 18 inches stroke. The current for the electrical plant was taken underground, and distributed to seven pumps, each being driven by an electric motor capable of developing 8 horse-power, and driving through worm gearing on a crank disc, to which the connecting rod of the existing pumps is coupled. The old plant, it is said, had a coal consumption of 30 tons per week, whilst that of the new plant only 9 tons in the same time, besides requiring less attendance by two men and two boys.

Electric Traction.—The Paris house of Messrs. Easton, Anderson & Goolden, Limited, has published a pamphlet describing the Holroyd Smith system of electric traction. The book is divided into several chapters, dealing with (1) General considerations on electric traction, specially referring to overhead and underground conductors; (2) The Blackpool Electric Tramway; (3) Improvements in the Holroyd Smith system since the Blackpool installation; also with some remarks on electric locomotives. The publication has been got up in first class style, it being very nicely printed, and containing a number of excellent illustrations, several of these giving views of the Blackpool tramways.

Exhibition at Amsterdam.—The Amsterdam International Hotel and Travellers' Exhibition, May till November, 1895, is to be held on a large scale. Its international character is a special feature, and a select committee to further its interests in Great and Greater Britain is being formed. Enquirers in the United Kingdom can have all particulars on application to the official agents for the Exhibition, Reuter's International Agency, Limited, 25, Old Jewry, London, E.C.

Factory Lighting.—The electric light has just been introduced into Mr. James A. Reid's new aerated water factory in James Street, Helensburgh. The whole of the works—office, loading passages, syrup room, stables, and coach-house—are lighted. There are four arc lamps and 36 incandescent lamps, equal to 4,000 candle-power. The contractors were Messrs. Walter Dickson & Co., Glasgow.

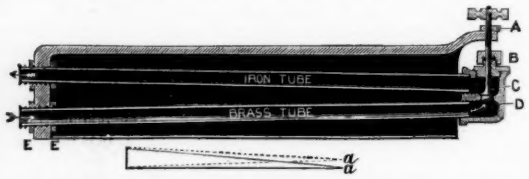
Fatal Accident.—On Thursday, last week, James M'Inulty, miner, New Cumnock, was killed instantaneously by coming into contact with the electric haulage apparatus in Bogside Pit, belonging to the Lanemark Coal Company. He was coming off his shift, and while on his way out of the horse road stopped to assist the boy driver to put on a hutch that had got off the rails. While in the act of lifting the end of the hutch the side of his head touched a defective casing in which the wire used to conduct the electric current runs, and stuck fast. Another miner, who was on the spot, caught hold of M'Inulty, but was thrown off by the force of the shock passing through his body. Presently the engine driving the electric apparatus stopped, and the body of the unfortunate man fell lifeless on the pavement. The deceased leaves a widow and young family of four.

For Sale.—The Brighton and Hove Electric Light Company, Limited, are offering for sale the whole of their plant, machinery and plant, at Brighton. Further details will be found among our advertisements.

Frank Suter & Co. v. L. Phillips & Co.—The plaintiffs, at the City of London Court last week, claimed the sum of £90 from the defendants, of Newgate Street, for supplying electrical appliances to their premises. Judgment had been entered for the plaintiffs on the claim for the reduced sum of £70; but the defendants raised a counterclaim for £62 10s. for advertising the plaintiff's business on a board. The jury found for Messrs. Suter, and judgment was entered accordingly.

Geipel's Steam Trap.—For the high steam pressures now increasingly adopted, it has been found that steam traps of the old forms are not well adapted, and the consequence is that much trouble and loss of steam has resulted from their use. Prof. Kennedy recently stated in his presidential address to the Institution of Mechanical Engineers *that the steam traps require more looking after than the whole of the rest of the machinery put together.* The reason of

this is twofold, being due, firstly, to the increased strain on the working parts and joints owing to the high pressure; and secondly, to the higher temperature of the steam. Steam traps may be divided broadly into two classes, the one being operated by gravity, the other by expansion and contraction, due to changes of temperature. In the former class the working parts are enclosed in a vessel generally made of cast-iron, while in the latter class the parts need not be so enclosed. This distinction is obviously in favour of the expansion trap, for not only does the case involve the removal of a cover, and the remaking of a joint each time the trap is inspected, but the continual oxidation of the levers and spindles, &c., used for opening and closing the valves causes rapid wear, and necessitates continual readjustment. The difficulty with the expansion trap has been due hitherto to the relative smallness of the motion set up in the linear expansion of the metal used, as well as in the positive nature of that motion. This has resulted in the cutting of the valve face, and in consequence, leakage through the valve; for when the trap has been set for use with steam at a particular pressure, and the valve arranged to close with "live" steam at that pressure, it is apparent that should the pressure be increased inadvertently, there is increased expansion, to which something must give way. The trap which we illustrate obviates both of these defects. In the first place the particular form in which the expansion parts are arranged, viz., that of an isosceles triangle, causes a considerable motion to be imparted to the apex for very small changes in the length of these parts; and in the second



place, there is a certain amount of elasticity in the pipes which there is not in the case of the direct thrust generally adopted in these traps. The illustration shows the method adopted by Mr. Geipel in putting his invention into practice. The lower or brass pipe is connected to the steam pipe, the upper iron pipe forming the discharge. These two pipes form the two sides of the isosceles triangle above mentioned, the valve seat, D, being at the apex. The valve spindle, *c*, is fixed to the frame of the trap. When cold, the brass pipe is contracted, the apex is drawn down to the position marked *a* (see diagram), so that the valve is fully open, and the water is discharged. As soon as steam enters the brass pipe, the latter expands, and raises the apex to the position marked *a*, when the valve is closed. In order that the valve may be set to blow off at any pressure desired, a screw adjustment is provided. In addition to this, when it is desired to blow through, the valve may be opened by hand, and, so that it shall not require resetting after blowing through, there is a locknut, "A," on the spindle. The valve may be readily examined by unscrewing the top, "B"; this is a desideratum, as it is a common occurrence for the valves in all steam traps to become choked with sediment or to require attention otherwise. The form of the trap is compact, and, therefore, is very suitable for fixing on the bed plates of engines, for which purpose existing traps are generally too bulky. It is also claimed for the trap that it is specially suitable for marine engines, where its use should involve a considerable saving of labour and attention, as well as effecting economy in steam by opening and closing the drain valves at the proper time. For the above particulars and drawings we are indebted to the makers, the Shillingford Works Company, of 12, London Street, E.C., who inform us that they have already supplied a number of these traps to different works, where they are giving satisfaction.

Newington, Priddle & Co., Limited.—A first dividend of 4s. in the £ is announced in the *London Gazette*.

Price Lists.—A new catalogue of electrical apparatus has been published by Messrs. Dorman & Smith. Electric light fittings, including brackets, pendants, lamps, reflectors, shades, hand lamps, switches, cut-outs, lampholders, fuses, and a variety of other electrical accessories. All the articles are well described and illustrated.

Mr. Julius Wallach, of 57, Gracechurch Street, E.C., has sent us one of his lists of cork coverings for steam pipes, hot and cold water pipes, &c. His system is that of placing the cork round the pipes, in sections; these sections are well-pressed on to the pipes and drawn closely together by the tightening of strands of wire with which they are fastened at certain intervals. Next the cork is spread with a covering of plaster, over which spun linen is wound, making altogether a very secure and substantial covering. Cork bricks for covering steam boilers, cylinders of steam and other engines are also supplied by Mr. Wallach. Another of his specialities is the metallic cotton belt.

Mr. A. W. Roy, of Newcastle-on-Tyne, has sent us a price list (October, 1894) of dynamos and motors of very small sizes manufactured by him. The list also gives prices of stampings for armatures.

Messrs. Carrick & Ritchie, of Edinburgh, has sent us a pamphlet describing and illustrating the improved turbines and other water motors for the utilisation of water for power, manufactured by them. Prices and full details are given and to intending users of water-power the list should be very valuable.

Mons. H. T. Cheswright, of 18, Rue de Maubeuge, Paris, who is agent in Paris for Mr. R. W. Paul, of Hatton Garden, has lately prepared a price list, printed in French, of the specialities manufactured by Mr. Paul. This list contains particulars and a number of illustrations of resistances, galvanometers, electrometers, and a variety of other instruments of the same class.

Proposed Electric Tramway at Llandudno.—At a meeting of the Llandudno Improvement Commissioners, last week, a letter was read from Mr. Alfred Dickenson, C.E., Birmingham, consulting engineer to the promoters of the proposed electric tramway from Deganway to Llandudno. He said that he had been instructed to prepare a scheme for the construction of a road between Deganway and Llandudno, and the erection of an electric tramway thereon. He had obtained the consent of the Llandudno and Deganway Land Company, and the Ecclesiastical Commissioners had approved of the scheme. Matters of detail only remained to be arranged with them. It was proposed to construct a 40-feet roadway to comply in the strictest sense with the specifications and requirements of the Commissioners, from Deganway along the shore of the River Conway. The system of traction to be adopted was the overhead electric system. After some discussion, the following resolution was passed by the casting vote of the chairman:—"That the board approves of the principle of constructing an electric tramway within the Improvement Act district, as shown on the plans produced."

Provisional Orders.—Among the various applications notified in the *London Gazette* to be made to the Board of Trade or Parliament during the 1895 session, are the following:—

City and South London Railway Company.—Act for extension of time for purchase of lands for, and for completion of underground railway authorised by their 1890 Act; power to alter the periods for holding general meetings; also to amend, alter, extend, or repeal the provisions, or some of them, of the Companies' Acts, 1884 to 1893.

Radcliffe Local Board.—Electric lighting provisional order.

Worthing Corporation.—Electric lighting provisional order.

Commissioners of Sewers of the City of London.—Powers to expend money necessary for supplying certain buildings with heat, water, and electricity.

Llandudno Improvement Commissioners.—Electric lighting provisional order.

Mersey Railway Company.—Powers to work railways with electricity or other motive power.

Notting Hill.—Extension of area by the Notting Hill Electric Lighting Company.

Winchester Corporation.—Electric lighting provisional order.

New Windsor Corporation.—Electric lighting provisional order.

Luton Corporation.—Electric lighting provisional order.

Bath Electric Lighting and Engineering Company.—Electric lighting provisional order.

Devonport:—Powers to the County of London and Brush Provincial Company for supplying electricity.

London United Tramways Company.—Powers for the use of electrical or other mechanical energy upon tramways.

City of Gloucester Tramways.—Powers for the use of electrical or other mechanical energy for use upon tramways.

Newington.—Powers to the County of London and Brush Provincial Company for electric lighting within the parish of St. Mary, Newington.

St. Olave's District Board of Works.—Power to the County of London and Brush Provincial Company to supply electricity within the area.

London, Deptford, and Greenwich Tramways Company.—Powers for supplying electrical or other mechanical energy, other than steam, upon their tramways.

Windermere and District.—Powers to the Windermere and District Electricity Supply Company to supply electricity within portions of the counties of Westmoreland and Lancashire.

St. George (Gloucester).—Powers to the Local Board to supply electricity.

Strand District.—Powers to the Charing Cross and Strand Electricity Supply Corporation for supplying electricity.

Salisbury.—Powers to the Salisbury Electric Light Company to supply electricity.

Battersea.—Powers to the County of London and Brush Provincial Company for supplying electricity.

Bootle Corporation.—For lighting the Borough by electricity.

Liverpool Electric Supply Company.—The last mentioned notice contains the following paragraph:—"To confirm and give effect to an agreement or agreements between the company on the one hand and the Corporation of Liverpool and the Toxteth Park Local Board, or one of them, on the other hand, relating to the supply of electricity, the excavation and reinstatement of streets, the sale by the company and purchase by such Corporation or Local Board of the company's undertakings and business, or part thereof, or otherwise relating to the undertakings of the company."

Sir John Pender and the Pacific Cable.—In the course of an interview which a representative of the Exchange Telegraph Company had recently with Sir John Pender, in reference to the proposed Pacific cable, that gentleman said there was an impression abroad that he was opposed to a Pacific cable. He was not opposed to the extension of submarine telegraphy wherever it was required, and wherever it could be used for the development of commerce, and if the colonies and Great Britain decided to have a cable by the Pacific, no doubt that cable would eventually be laid. But in the present depression of trade in the colonies, he doubted if they would be disposed to commit themselves to additional outlay for submarine cables, when at the present moment they possessed all the advantages which submarine cables could give them. There was a sort of craze at the present time over this Pacific cable, and an attempt had been made to show that it was an absolute necessity, and that the want of the cable was rather retarding the progress of the colonies. He thought that as a telegram between Canada and Australia, or the Cape of Good Hope *viâ* London, occupied only about two hours in transit, the laying of a Pacific cable immediately was not imperative; and, considering that the amount of money involved

would be about two millions, or, if the cable were duplicated, four millions sterling, he believed that the shrewd and wise men who were at the head of the respective Governments would seriously consider the cost before they agreed to expend such a large sum of money, unless they could see that such an expenditure would largely benefit the trading interests of the Empire. But if the Governments determined to have this additional cable, he believed that his company were in a position to undertake the work on better terms than any other company could do it, and he would warmly co-operate with those Governments to extend the system without damaging the companies which, they all admitted, had given them such a satisfactory and beneficial telegraphic service.

Submarine Telegraphy.—To celebrate the twenty-fifth anniversary of the establishment of submarine telegraphy to the Far East, a dinner was given last Friday night at the Holborn Restaurant to the staffs of the Eastern, Eastern Extension, and associated telegraph companies. Mr. J. Denison Pender, the managing director, presided, and the company numbered nearly 200.

Telegraphs in Africa.—Mr. Cecil Rhodes is ordering 650 miles of materials to be sent out for the construction of his Cape to Cairo telegraph line. It is estimated that this additional material will suffice to build the line from Blantyre to Ujiji on Lake Tanganjika.

The Electric Joint Stock Company, formerly Schuckert & Co., of Nürnberg.—The very prosperous company, formerly known as Schuckert & Co., possesses now technical offices at Dresden, Manheim, Bremen, Augsburg, Hanover, St. Johann-on-the-Saar, Dortmund, and Nürnberg, and has also branch establishments at Leipzig, Cologne, Hamburg, Munich, Breslau, Frankfort-on-Main, and Berlin. The writers of a pamphlet, published by the company, on the "Applications of Electro-motors for Industrial Purposes," say that the advantages of electro-motors for the transfer of power, as compared with steam, gas, petroleum, benzene, motors, &c., have induced them to describe and figure their apparatus, as adapted to a number of arts and industries. For this purpose they give illustrations showing the working of ventilators, sewing machines, passenger lifts, agricultural machinery, mills for grinding painters' colours, wine pumps, printing machines, glazing machines for paper and cardboard looms, circular saws, machinery for manufacturing jewellers, excavating machines, and shaft pumps. The illustrations are 35 in number. This pamphlet may give not a few useful hints for the application of electricity in this country, where the smaller manufactures are being too much neglected, and are, in consequence, passing more and more into alien hands.

The Halifax and Bermudas Cable Company.—We hear that this company has given formal notice that it will make application to Parliament in the ensuing session for an Act, the purposes of which are set forth in the following legal terms:—"To make further provision with reference to the investment of the annual subsidy or yearly sum payable by Her Majesty's Treasury to the Halifax and Bermudas Cable Company Limited (hereinafter called the company) or to the Trustees for the holders of Mortgage Debentures issued by the Company under a certain Indenture or Deed of Trust dated the 2nd day of July 1889 and made between the Company and the persons therein named as Trustees and to authorise the investment and reinvestment of such annual subsidy or yearly sum and of any available portion thereof and any sinking fund which may have been created and any other moneys received or to be received by the Company or the said Trustees upon such stocks funds and securities as the Company and the said Trustees may approve or as may be prescribed or provided by the intended Act; and to authorise and provide for the application from time to time of such annual subsidy or yearly sum and other moneys and the proceeds of any such investments in the purchase redemption payment off and extinction of the Mortgage Debentures issued by the company under the said deed with the interest thereon in such manner and at such times and on such terms and conditions as may be prescribed or provided by or in accordance with the intended Act, and to require the holders of such mortgage debentures to submit to such redemption payment off and extinction accordingly. To alter amend enlarge vary or rescind some of the provisions covenants and conditions of the said deed and the terms and conditions of the said debentures and to make other provisions in lieu thereof or in addition thereto. To confer and impose on the company and the said Trustees and the holders of the said Debentures all such powers rights privileges and obligations as are or may become necessary for carrying into effect the objects of the intended Act; to vary or extinguish all rights and privileges which would in any manner impede or interfere with such objects and to confer other rights privileges and exemptions and to make such other provisions as may be necessary or incidental to the objects and purposes aforesaid. The intended Act will or may sanction confirm and give effect to any agreement or arrangement which has been or may be made relating to the matters aforesaid or any of them. And notice is hereby given that on or before the 21st day of December next printed copies of the Bill for the intended Act will be deposited in the Private Bill Office of the House of Commons."

The Pneumatic Typewriter, Limited.—This company was recently formed for the purpose of acquiring and working certain patents connected with type-writing machines. The capital is £100,000. The only point of interest to our readers is that a contract, dated November 15th, 1894, has been entered into with the Consolidated Telephone Construction and Maintenance Company, Limited, for the entire manufacture of the machines.

The "Realm."—With this title a new three-penny weekly paper has been commenced in London. The aim of the editor appears to be to produce a combined political and society organ, but there are a number of articles devoted to other subjects of general interest. In fact, the paper contains a little of everything, and we consider it well worth the price charged for it, though there are so many journals of this class that we should hardly have thought there was room for it. There is an appearance of dignity throughout its columns and a good title has been selected. We wish the editors success.

The Richardson Inverted Arc Lamp.—From Mr. A. W. Richardson, of Patricroft, we have received a list of his inverted arc lamp, which is a differential focussing brake wheel lamp. A large wheel gears into two racks in which a pinion gears, the brake wheel being on the same arbor. The brake arrangement is attached to a locking lever, at each end of which are fixed the cores of the main and shunt coils of a large area, which allow of a most sensitive and continuous feed. The list also gives prices of the lamp, and a list of seven requirements of a well-lighted workshop.

CONTRACTS OPEN AND CLOSED.

OPEN.

Cardiff—December 4th. The Corporation is prepared to receive tenders for the supply of steam coal for the electric lighting works at Canton for six months, ending June 10th, 1895. Particulars may be obtained from Mr. W. Harpur, M.Inst.C.E., borough engineer.

Coventry.—The City Council are requiring a quantity of electricity meters, and Mr. Hammond has told the council that there are only about half-a-dozen firms making the meters wanted. Further particulars will be found in our advertisements.

Enniscorthy (Ireland).—December 11th. Tenders are invited for providing the Enniscorthy District Lunatic Asylum with internal telephonic communication; about 13 stations required. Further particulars can be obtained from the resident medical superintendent.

London, N.—December 8th. Tenders are invited for the supply of new, and the purchase of old, stores, for 12 months from January 1st, for the Great Northern Railway Company. A list of the contracts, &c., may be obtained upon application to Mr. Martin, stores superintendent, Doncaster. The patterns of telegraph and electric lighting material will be exhibited at the Telegraph Stores, Retford.

Melbourne (Victoria).—The Corporation of the City of Melbourne are inviting tenders for the supply, delivery and erection of alternating current dynamos, exciters, switchboard, transformers, instruments, &c., for the electric lighting of the city. We have in our possession a few copies of the specification and conditions of contract, and shall be pleased to hand these, upon application, to firms desirous of tendering for the work.

CLOSED.

Harrow.—The tender of Messrs. Crompton & Co. for lighting the school, chapel, library, and other school buildings by electricity, at £8,762, and £1,686 for maintenance, has been accepted.

Islington.—Recently the tender for the supply of structural iron and and steel work required in the execution of the central station was referred back to the Electric Lighting Committee. On November 2nd fresh tenders were invited, and the tender of Messrs. Moreland & Son for £1,943 12s. 7d. (the lowest tender) was accepted, subject to the usual conditions. The other tenders sent in were—

Messrs. Dick Kerr & Co.	£2,504	9 8
„ Dorman, Long & Co. ...	2,028	11 6
„ Drew, Bear & Co.	2,179	0 0
„ Handyside & Co.	2,400	0 0
„ Morton & Co.	2,250	0 0
„ Shaw & Co.	——	

Salisbury Estate.—We understand that 34 tenders were received for the electric lighting of the above, the totals for the whole job varying from £5,437 to £8,473. The lowest tender was from Messrs. B. Verity & Sons, who offered a combination of Edwin Danks's dry back boilers and Parsons turbines, and made stronger guarantees than any other tenderer in reference to absence of vibration. The contract has accordingly been allotted to that firm.

Sunderland.—The following tenders have been accepted:—Messrs. Reed, Ferens & Co., for laying wires; Messrs. Crompton and Co., Limited, for altering gas fittings. Further details will be found among our "Business Notices."

NOTES.

The Berlin and Vienna Telephone.—The telephone line between Vienna and Berlin has just been finished, and the first experimental conversation, which was carried on between the two cities last Friday, was said to be successful. The line will be opened for public use in a day or two. It is expected that there will be a very large amount of patronage for the line, especially in the way of communications between the two Bourses—so large, that it is anticipated that a second and, perhaps, even a third line will very soon be required. During business hours the present line will be exclusively at the disposal of the Bourses in the two cities. A despatch from Berlin says that the line is about 800 kilometres, or 500 English miles in length, and it is reported that it does not yet act very satisfactorily.

Circulating Economisers.—Referring to our article of November 23rd, on "The Coal Question and Fuel Economiser," we observe that tests have been already made of ordinary and circulation type economisers by the four leading boiler insurance companies in Manchester, which appear to show very little difference indeed between the two types in regard to efficiency, but, if anything, the results are rather in favour of the older system. Indeed, the tests practically bear out what we wrote on the subject, and confirms us in our opinion that practically the best results are to be obtained by putting two or three economisers in series, but maintaining the parallelism of the pipes themselves in each group. Thus in an apparatus of 320 pipes it does not look wise to force all the feed water through 400 feet of pipes, as in the circulation system, but there is not the same objection to making it travel a matter of 20 or 30 feet, as in the method we favour. In the ordinary method, 10 feet is the length of travel; the speed of flow being inversely as the length passed through by each particle of water. We do, however, feel strongly that whatever be the system adopted, the water should be first warmed before putting it through the economiser to destroy the bottom boxes and lower ends of the pipes by rapid corrosion. We think there are opportunities of doing this either, as suggested, with a few old pipes not under pressure, or with a coil in the exhaust pipe between cylinder and condenser. Failing this, the return of some of the heated water to the cold feed should be the system followed. We have frequently seen the working of scrapers stopped by the accumulated scale at the lower ends of pipes, entirely caused by the condensation due to the cold feed.

Madrid again in Darkness.—The *Imparciàl*, of Madrid, formulates very serious complaints against the electric lighting company, the "Sociedad Madrilena de Electricidad." On the evening of the 21st inst., says our contemporary, many theatres had to suspend the performances on account of the failure of the electric light, while the inconvenience caused to the cafés, restaurants, and private houses served by this company was enormous. The *Imparciàl* calls upon the authorities to put an end to this abuse, and compel the "Sociedad Madrilena" to fulfil its obligations with its subscribers, who pay so dearly and are so badly served. Our readers will remember that we had to report the complete breakdown of this company's system on the evening of October 30th, and, according to the *Imparciàl*, the failures since that date of their lighting arrangements have been frequent.

The Madrid *El Liberal* says:—"In consequence of the repeated failures in the electric lighting of Madrid, that is to say, in those districts supplied by the Compania Madrilena de Electricidad, and in view of the high price charged for this lighting, it is proposed to utilise the waters of the Manzanares river, for the supply of electrical energy for the purposes of electrical lighting and motive power. It is proposed to erect a transmitting station at a point where the river leaves the Guadarama range; here, it is said, a fall of 120 metres, supplying 2,000 litres per second, is available. It is calculated that this power, transformed into electrical energy, will permit of the delivery in Madrid, allowing for all possible loss, of 26,400 kilowatts daily. Consumers pay from 9d. to 10d. per kilowatt for the existing lighting, and it is estimated that under the proposed scheme the price will be reduced to about 5½d. per kilowatt. The cost of the new installation would not exceed, it is said, £100,000.

Royal Statistical Society.—At the special meeting to be held in the Lecture Theatre of the Museum of Practical Geology, 28, Jermyn Street, S.W., on Tuesday, December 4th, 1894, at 4.45 p.m., there will be an exhibition of the Hollerith electrical counting machine, by Dr. Herman Hollerith, Washington, D.C., U.S.A.

Rotten versus Aron.—Last month, the action brought by Messrs. Rotten against Herr Aron, to revoke his patent for the construction of clock supply meters, was tried in Germany. It was maintained by Messrs. Rotten that the Aron patent of 1884 was anticipated by the Ayrton and Perry English patent, No. 2,642, of 1882, which claims the method of measuring electrical energy by the gain or loss produced in a clock, and that a description of the Ayrton and Perry supply meter was published in Germany in 1883, in Mr. Shoolbred's paper on "The Measurement of Electricity for Commercial Purposes," which was read before the Society of Telegraph Engineers in the spring of that year. Herr Aron contended, on the other hand, that although the principle originated with Profs. Ayrton and Perry, the illustrations of their clock supply meter in Mr. Shoolbred's paper shows only one fixed stationary coil carrying the main current, fixed behind the fine wire pendulum coil, and that his own improvement consisted in placing the stationary coil, or coils, which conveyed the main current *symmetrically* with reference to the pendulum coil. The plaintiffs replied that the illustration in Mr. Shoolbred's paper was only diagrammatic, and that no meter had been sent out by Profs. Ayrton and Perry which did not possess *two* stationary coils, conveying the main current, placed *symmetrically* on the two sides of the pendulum coil. The Court decided that the Aron patent must be modified so that the claim should cover only the symmetrical arrangement of the coils in the clock supply meter. It is interesting to note that, in spite of the many supply meters that have been brought out during the past 12 years, the Ayrton and Perry clock method of constructing an electric supply meter should be still regarded of sufficient commercial value as to lead a German firm to carry through an action, in order that they might obtain a legal right to employ this method in the construction of meters.

Resuscitation after Electrocution.—A despatch dated New York, November 25th, says that Dr. Gibbons, of Syracuse, who professes to be able to restore animation to a person who has been executed in the usual manner by electricity, has arrived here for the purpose of explaining to the members of the medical profession his apparatus. It is a species of double bellows, about 2 feet in length. By pulling a handle, after an India-rubber tube has been inserted into the throat, one bellows is filled with fresh air, or oxygen, while the other extracts from the lungs whatever air they may contain. By another movement of the handle pure air is projected into the lungs and the vitiated air is thrown out of the bellows. Notwithstanding the decision of the Attorney-General for the State of New York that it would not be legal to experiment upon the body of an electrocuted man, Dr. Gibbons hopes to be afforded an opportunity to carry out such an experiment within the next two or three months. He declares that he is satisfied the alternating current of 1,700 volts now applied does not kill, but only suspends animation, and that it is really the knives used by the surgeons at the autopsy that causes death. He does not claim that by means of his bellows he will be able to actually restore life, but he declares that he can resuscitate a person apparently executed by the alternating shocks of electricity now applied. His method is to place in the mouth, or preferably in the trachea of the apparently dead criminal—in the latter case after tracheotomy has been performed—the India-rubber tube attached to the bellows, and then working the latter in the manner described. He considers the experiment after tracheotomy would have a better chance of succeeding, because it is often necessary in cases of suspended animation to administer nourishment through the mouth. He says he has experimented largely upon dogs, rabbits, cats, sheep, and cattle, applying from 1,500 up to 2,500 volts, and that the animals under his treatment subsequently revived. Dr. Gibbons adds that the periods of apparent death varied from a few moments to several hours, and that he has an assistant who has been similarly revived after receiving 1,500 volts.

Niagara.—We read in the *Financial News* that "six companies are drawing great volumes of water to turn turbines which generate electric power, and the Governments of Canada and the United States have been appealed to to prevent further appropriations of water which ought to go over the Falls instead of escaping them by going through mill streams and tunnels. The struggle between Nature and utility is reaching quite an acute stage."

The Paris Sector for the Distribution of Electrical Energy.—The Paris Compressed Air Company, who have obtained from the Municipal Council the grant of a sector in Paris, have recently made in their council of administration certain changes that may involve serious consequences. Messrs. Siegfried, Lalance, Kœchlin, Ewald, Journet, Pirani, administrators of the Clichy Sector, have been enrolled in the council of administration of the sector, granted to the Paris Compressed Air Company. The result is that the two sectors now belong to one and the same company, which is contrary to the specification. M. Attout-Taillfer, municipal councillor, has, therefore, asked if the Council would not be justified in withdrawing from the Paris Compressed Air Company the right of laying electric mains along the public streets. The question is to be submitted for consideration to the First Committee of the Municipal Council.

A New Method of Determining Conductivity.—Kohlrausch's method of determining electrical conductivity appears to be unsuitable for application to slightly dissociated compounds, and almost useless for organic bases, or acids in alcohol or other organic solvent, whilst even when applicable to such cases, it is well known to be troublesome and extremely tedious. Consequently, M. Wildermann has recently devised a method which he claims to give much more satisfactory results. The chief difference lies in the use of a far stronger electromotive force, by which the polarisation becomes practically negligible, and a galvanometer can be employed instead of the telephone; whilst, as the external resistances are very great, the measurement of the conductivity resolves itself into the measurement of the current, this being always done comparatively. Wildermann uses an E.M.F. of about 140—150 volts, which he obtains from 100 Clarke's elements, the liquids under examination being placed in capillary tubes of varying length and diameter. The results obtained in the cases of oxalic acid and acetic acid, for example, when compared with those derived from Kohlrausch's method, shows satisfactory agreement. Experiments are recorded by Wildermann (*vide Zeitschrift für Physikalische Chemie*, xiv., p. 247), which appear to substantiate his claims that the modified method adopted by him is of very considerable value.

NEW COMPANY REGISTERED.

Nalder & Harrison Construction Syndicate, Limited (42,492).—This company was registered on the 17th inst. with a capital of £15,000, in £1 shares, to adopt an agreement to purchase and develop patents, and to carry on financial, commercial, trading, and other operations. The subscribers (with one share each) are: N. F. Nalder, 94, St. George's Square, S.W., engineer; H. J. Harrison, 12, Dryden Mansions, S.W., engineer; F. W. S. Jones, 33, Old Broad Street, E.C., engineer; F. R. Boardman, Leytonstone, secretary; H. L. Osmond, 10, Lanhill Road, W., engineer; T. Miles, 65, High Street, W.C., engineer; H. Fould, Stockwell, secretary. There are not to be fewer than two, nor more than seven, directors; qualification, one share; remuneration not yet fixed. Registered by Russell & Arnholz, 17, Great Winchester Street, E.C. We understand that the capital has all been privately subscribed.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Aurora Electric Lighting and Distribution Company, Limited (34,109).—This company's yearly return, filed October 9th, 1894, shows that out of a nominal capital of £25,000 in £1 shares, 5,935 shares have been taken up, and that the full amount (£935) has been called and paid on 935 of these. A sum of £5,000 has been agreed to be considered as paid.

Babcock & Wilcox, Limited (34,289).—This company's annual return, filed October 2nd last, shows that out of a nominal capital of £240,000 in 10,000 preference and 14,000 ordinary £10 shares, the whole of these shares have been taken up. The full amount has been called on 6,667 preference and 9,334 ordinary, £160,010 has been received, and £79,990 has been agreed to be considered as paid.

British Electro-Chemical Agency, Limited (34,592).—This company's last yearly return shows that out of a nominal capital of £75,000, in £5,000 ordinary and 2,500 vendors' shares of £10 each, 2,500 of the first class, and an equal number of the second, have been taken up, and that £3 has been called on each of the ordinary shares, and the full amount on the vendors. A sum of £6,941 has been received, £25,000 has been agreed to be considered as paid, and £559 is outstanding.

Bournemouth and District Electric Supply Company, Limited (34,129).—This company's annual return shows that out of a nominal capital of £50,000 in £5 shares, 5,725 shares have been taken up, and that the full amount has been called on each. The sum received in response to calls is, therefore, £28,625.

Buenos Ayres Electric Light Company, Limited (16,057).—This company filed its return on September 4th last. This document shows that out of a nominal capital of £100,000, in £9,986 £10, and 70 £2 founders' shares; the whole of the founders' shares have been taken up, and that nothing has been either called or paid.

J. C. Howell, Limited (36,794).—On the 12th inst. this company filed its yearly return, which shows that out of a nominal capital of £25,000, in £5 shares, 2,907 shares have been taken up, and that the full amount has been called on each of 907 of these. A sum of £4,510 has been received, and £10,000 has been agreed to be considered as paid.

Laurence, Scott & Co., Limited (27,260).—This company's yearly return, filed on the 6th inst., shows that out of a nominal capital of £30,000 in £10 shares, 1,406 shares have been taken up, and that the full amount has been called on 906 of these. A sum of £9,060 has been received, and £5,000 has been agreed to be considered as paid.

Ronald A. Scott, Limited (41,372).—The statutory return of this concern shows that out of a nominal capital of £10,000, in £1 shares, 5,007 shares have been taken up, of which seven shares have been paid in full. A sum of £5,000 has been agreed to be considered as paid.

Siemens Brothers & Co., Limited (14,777).—This company's yearly return shows that out of a nominal capital of £500,000, in £100 shares, the whole of the shares have been taken up, and that £85 has been called on each. The total received equals £425,000.

St. Martin's Electrical Manufacturing Company, Limited (38,030).—This company's statutory return shows that out of a nominal capital of £500, in £5 shares, 45 shares have been taken up. The full amount (£225) has been called and duly paid.

Allan Everitt & Sons, Limited (31,632).—This company has just filed its yearly return, which shows that out of a nominal capital of 300,000 in £10 shares (10,000 preference and 20,000 ordinary), the whole of the preference, and 12,000 ordinary shares, have been taken up. A sum of £131,000 has been received in response to calls, viz., £8 on each of 8,000 ordinary and £10 on each of 6,700 preference shares. There have been 3,300 preference and 4,000 ordinary shares issued as fully paid.

Windermere and District Electricity Supply Company, Limited (41,461).—This company's statutory return has been filed. It shows that out of a nominal capital of £50,000, in £5 shares, 307 shares have been taken up. A sum of £1 has been called and fully paid on seven shares, but nothing has been yet called on the 300 shares remaining.

Westinghouse Electric Company, Limited (29,834).—This company has filed its annual return, which shows that out of a nominal capital of £600,000, in 30,000 preference and 30,000 ordinary shares, all of £10 each, 18,955 preference and 20,000 ordinary shares have been taken up. The full amount has been called on 1,835 preference, and 10s. a share has been called on 1,820 shares of the same class. The return states that the whole of the ordinary and 15,800 preference shares were issued as fully paid.

Wimshurst, Hollick & Co, Limited (41,466).—Out of a nominal capital of £40,000 in £5 shares (4,000 ordinary and an equal number preference), says this company's statutory return, all the ordinary shares, and 628 preference shares, have been taken up. The full amount has been called (£3,140) and paid on the preference shares, and the ordinary shares have been issued as fully paid.

CITY NOTES.

The County of London and Brush Provincial Electric Lighting Company, Limited.

In our last issue the report of this company's meeting was headed "*City* of London, &c., &c." Our readers doubtless detected the error when reading the account.

Westminster Electric Supply Corporation.

An extraordinary meeting of the holders of the founders' shares and of the shareholders of the above corporation, was held on Wednesday morning at the offices, Eccleston Place, S.W., to pass several resolutions.

Mr. J. H. Powell presided, and formally moved:

"That out of the newly created share capital of £100,000, £40,000 in 8,000 shares of £5 each be forthwith issued at a premium of £1 per share, and in the first instance allotted to shareholders on the register on November 14th, 1894, in the approximate ratio of one to every complete eight shares then held, and that the board be empowered to allot any balance of the 8,000 shares not allotted to the shareholders, to members of the staff of the corporation, or to such other persons as they may think fit on the same terms."

"That the amount due on the shares be payable as follows:—£1 (premium) on January 3rd, 1895; £2 on January 15th, 1895; and £3 on July 1st, 1895; and that the new shares rank for dividend (on amount of capital paid) from January 1st, 1895."

"That the balance of 12,000 shares be retained, and that the board be authorised to issue them as required, they being first offered to the shareholders on the register at the time of such issue, and on such terms as the board may consider desirable."

After a little discussion the resolutions were adopted.

Place Clichy District Electric Lighting Company.

The above company met in general meeting on the 18th ult. The works of this company are in the Rue des Dames. The power has not been augmented, having been sufficient to face all demands, but arrangements are in progress to add two 500-H.P. units during the current year, and four new boilers, the engines to be vertical Corliss, like the last installed unit, the boilers to be of Nœyer type, as before, but with superheaters. Two new transformers will complete the plant. The accumulators suffice to assure the necessary reserve. Many improvements have been made outside the machinery, such as the ventilation of the machine room by an air shaft, enlarged coal stores, and augmented water storage, furnished with filters. The extent of wiring is developing as demand increases, and demands have been numerous in new built districts. Feeder lines have grown over 2,000 metres; the network of distribution by nearly 7,000 metres. Actually this extends over about 52 kilometres, and includes 291,750 metres of cable, which has grown to this from 134,293 metres in 1891. The system of regulation gives excellent results, and will be completed by the establishment of rheostats on the feeders, which cannot be deferred much longer. Branches and vertical mains have grown to 788 and 302 respectively. Simple interior branches and branches from vertical mains, to 464 and 755 respectively. The vertical mains are being better used; the 302 are able to feed 1,812 flats. They actually do supply 755, or 41 per cent., as against 38 per cent. last year, though 137 of them are newly installed, and supply, so far, scarcely more than one subscriber each. There were 1,221 meters on June 30th, as against 752 the previous year. They indicate exactly and are easy to manage. The number of subscribers was 1,208, an increase of 62 per cent. The number of lamps installed, reduced to equivalent 10 C.P., has grown to 69,860, an increase in the year of 53 per cent., installed chiefly in private apartments. The number of lamps per subscriber has gone down to 57, instead of 60, an indication of the extension of the light to more modest interiors, and there are now 140 lamps per 100 m. of conduit, as against only 100 lamps the previous financial year. This compares with the 158 lamps per 100 m. for lighting alone of the Edison Company, of New York, and 224 lamps taking account of the motive power current. In Paris, motors have not progressed well. In New York, motive power takes 20 per cent. of the total current, while in Paris they take but 3·4 per cent., but electricity is coming to be used for elevators, not only because it is easily applied, but because it is cheaper than hydraulic power. It is not thought that the Auer gas burner will stand against electricity; the public will hardly abandon the comforts of electricity and put up with an apparatus that has all the objections of gas. Only five subscribers have changed back to gas, while two old users of the Auer burner have become subscribers to electricity. The total capital being eight million francs, there is a total income of 1,230,376 francs, and a net profit of 764,284 francs, of which, after paying all expenses, fees, taxes, interest, reserve, and amortisation, there remains 200,000 francs, or sufficient to pay 5 per cent. on the ordinary stock, from all of which it would appear that the company are doing well, the fund now available towards amortisation of capital being 420,476 francs.

Allgemeine Elektricitäts Gesellschaft.

The report of the directors for the twelfth year of the Universal Electrical Company, from July 1st, 1893, to June 30th, 1894, to be presented to the general meeting on November 29th, 1894, sketches the development of electrotechnics from the introduction of the glow lamp. The directors consider that the objection to overhead wires is no longer felt as a hindrance to the introduction of electrical tramways. In like manner the use of electricity for impelling machinery is now ceasing to encounter opposition on the part of manufacturers. Strong emphasis is laid by the directors on the value of the rotatory current as *the* system for the transfer of power. An agreement into which the company had entered with the firm of Siemens & Halske was dissolved in March last. Among the results of the past twelve months, it is noticed that the Halle electric lines show a satisfactory development of traffic. The negotiations with the old tramway there are proceeding favourably. The tramways of Kiew, Essen, Chemnitz, Dortmund, Christiania and Lübeck, are all now in operation. The tram lines at Plauen and Altenburg are in course of construction. The company has acquired the shares of the Genoa electrical and wire-cable tram lines, and is working them on behalf of the Societa de Ferrarie Elettriche. Electrical central stations are in course of execution at Barcelona, Seville, Craiova, Copenhagen and Strassburg. In the last-mentioned city, and at the installation for the suburbs of Berlin, the rotatory current will come into play on a large scale. The company has also acquired the concessions for tram lines at Königsberg and Leipzig. It participates, also, in the installations of the Electro-chemical Works at Bitterfeld. The directors propose to pay a dividend of 9 per cent. The profits of the company amount to 3,205,981 marks, being 591,069 marks in excess of that realised in the previous business year.

Stock Exchange Notices.—The Stock Exchange Committee have (1) appointed a special settling day as under:—Monday, December 3rd—Metropolitan Electric Supply Company Limited, £150,000 4½ per cent. first mortgage debenture stock. And (2) ordered the undermentioned securities to be quoted in the Official List:—City and South London Railway Company, further issue of £39,000 4 per cent. perpetual debenture stock, and 650 5 per cent. perpetual preference shares, Nos. 7,001 to 7,650. Metropolitan Electric Supply Company, Limited, £150,000 4½ per cent. first mortgage debenture stock.

The Eastern and South African Telegraph Company, Limited.—The company have advertised the numbers of the 5 per cent. mortgage debentures which have been drawn for payment at par on January 1st, 1895, at the banking house of Messrs. Barclay, Bevan & Co., 54, Lombard Street, E.C., when the interest thereon will cease.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30th last, and payable on December 21st. The transfer books of the company will be closed from the 14th to 20th December, both days inclusive.

The Electric and General Investment Company, Limited.—The directors have declared an interim dividend on the capital paid up on the ordinary shares of the company at the rate of 10 per cent. per annum for the six months ending November 30th, 1894, the dividend to be payable on and after December 20th next.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 25th, 1894, amounted to £957; week ending November 26th, 1893, £897; increase, £60; total receipts for half-year, 1894, £18,648; corresponding period, 1893, £17,370; increase, £1,278.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending November 25th, 1894, amounted to £913; corresponding week last year, £880.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 23rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,415.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, November 21st.	Closing Quotation November 28th.	Business done during week ended November 28th, 1894. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	102 —105	102 —105	...	...
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	38 — 39	38 — 39	38⅞	38
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	72 — 73	72 — 73	72⅞	72
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	6½— 7	6½— 7	6½	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	11 — 11½	11 — 11½	11½	11
75,000*l*	Do. do. 5 %, repayable June 1906	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10% ‖ §	... §	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	135 —145	140 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	2 % §	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½— 13½	12½— 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	19⅞	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4¼— 4⅜	4¼— 4⅜	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9½— 9¾	9½— 9¾	...	...
30,000*l*	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	2⅝% §	8¼— 8⅜	8¼— 8⅜	8½	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½% §	15⅝— 16	15⅝— 16	16	15⅞
70,000	Do. 6 % Pref.	10	6 % §	6 % §	6 % §	16½— 17	16½— 17	16 1/16	16⅛
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —110	106 —110	...	...
1,297,837*l*	Do. 4 % Mort. Deb.	Stock	...	...	...	117 —120 xd	117 —120	119	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅞— 16⅛	15⅞— 16⅛	16⅛	15⅝
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —107	103 —107	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	104 —107	104 —107	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	116 —120	117 —121	120½	120
95,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —107	103 —107	...	...
129,100*l*	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	104 —107	104 —107	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	104 —107	105⅜	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107—110% xd	107 —110%	108¾	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4⅞% §	4⅝% §	8⅜— 9	8⅜— 9	8 15/16	8⅜
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅜— 16¼	15⅜— 16¼	16⅛	15⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜% §	20½— 21½	21¼— 21⅜	...	...
190,000*l*	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	46 — 48	47 — 49	48¼	47⅜
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	...	...	...	102 —106	102 —106	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	¼— ⅜	¼— ⅜	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2 xd	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	5 % §	4⅞— 5⅛	5 — 5⅛	5⅛	4 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 16	15 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	15 — 16	15 — 16	15⅞	15½
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅜— 5⅞	5⅜— 5⅞	5⅞	5⅜
1,000,000*l*	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	110 —113	110 —113	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	1/16— 1/8	1/16— 1/8	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	104 —107	104 —107	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	0 %	3 — 5	3 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	103 —108	103 —108	106	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2 — 3	2 — 3	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	...	...	...	88 — 94	88 — 94	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	...	0 %	3 — 5	3 — 5	...	...
249,900*l*	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	102	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	100 —105	100 —105	102⅛	100⅝
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	2½%	10 — 10½	10⅛— 11	10 1/16	10⅛
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6½— 7	6½— 7	...	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	4½— 4⅝	4½— 5	4⅞	4⅝
171,900*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	101 —105	101 —105	101½	...
214,800*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1¼	1 — 1¼	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	11 — 11½	11 — 11½	11⅜	11 1/16
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	...	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	108 —111	108 —111	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	112 —118	112 —118	...	...
166,900*l*	Do. do. 6 % Ster. Bonds.	100	...	...	...	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½— 5⅛	4½— 5⅛	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	12½— 13½	12½— 13½	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14⅞— 15¼	14⅞— 15¼	15¼	15
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	131 —133	131 —133	...	...
50,000	†Liverpool Electric Supply, all paid	5	4½%	5 %	5 %	7 1/16— 7 3/16	7 1/16— 7 3/16	7 3/16	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½%	9½— 9⅞	9½— 10	9⅞	9 7/16
100,000*l*	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	6½— 7½	6½— 7½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	7⅛— 8	7⅛— 8	7 1/16	7⅛
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9	8½— 9	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	7 — 7⅛	7 — 7⅛	7⅛	7 1/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, Nov. 21st.	Closing Quotation, Nov. 28th.	Business done during week ended Nov. 28th, 1894. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2¼— 2½	2⅜— 2⅝	2⅝	2⅜
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼— 2½	2¼— 2½	2⅝	...
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	110 —113	110 —113	...	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	39 — 41	40 — 42	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	2¾— 3¼	2¾— 3¼	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½— 2	1½— 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	*nil*	1/16— ¼	1/16— ¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1⅜— 1⅝	1¼— 1½	1⅜	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1½— 1⅝	1 — 1¼	1 1/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½— 1½	½— 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	8 — 9	8 — 9	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	25 — 26	25 — 26	25⅞	25½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	102 —104	103	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	7 15/16— 8 1/16	7 15/16— 8 1/16	8	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	13 — 13¼	13 — 13¼	...	...
	Swan United Electric Light, Ltd.	...	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	41 — 43	41 — 43	42⅞	42½
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	106 —109	106 —109	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2⅛— 2⅜	2⅛— 2⅜	2⅜	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
House-to-House Company (£5 paid), 2¼—2½.
Do. do. 7 % Preference, of £5, 6⅛—6⅜.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅞—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

The discussion on: (1) "Notes on Electric Tramways in the United States and Canada" (supplementary paper), by H. D. Wilkinson. (2) "Electric Traction, with Special Reference to the Installation of Elevated Conductors," by R. W. Blackwell and Philip Dawson. (3) "Electrical Steep-Grade Traction in Europe," by Chas. S. du Riche Preller, were taken together.

The President, at the meeting last Thursday, announced the death of an old member of the Institution in Colonel Armstrong, who had had a great deal to do with the development of the submarine defences of the country. He was also the first electrical adviser to the Board of Trade. He moved that an expression of sorrow at the occurrence be recorded in the Transactions of the Institution.

Dr. Du Riche Preller then read the following paper:—

"Electrical Steep-Grade Traction in Europe."

Introduction.

The rapid growth of electrical traction in Europe, wherever local conditions and reasonable official regulations are conducive to its adoption, is evidenced by the fact that within the last few years it has also been extensively applied, and is in course of further application, on steep-grade or mountain railways properly speaking—that is, on lines which have not only occasional steep-grade sections, such as occur, for instance, on many electrical tramways, but continuous gradients varying from 5 to 25 and upwards of 60 per cent. (1 in 20, 1 in 4, and 1 in 1·6 respectively), and which connect either the base and summit of a given declivity, or different districts separated by a mountain range.

It will, therefore, not be inopportune if I place before the Institution a short synopsis of what has been already done in Europe in that branch of electrical engineering, together with certain conclusions and proposals founded on my own experience.

Leaving aside for the present, as being more suitable for separate treatment, the question of heavy—viz., 50 to 100-ton—electrical locomotives for trunk railways, the working of steep grades by electricity may be considered under two heads:

1. By cable traction; and,
2. By motor cars or locomotives with fixed conductors.

Cable Traction.

Up to a recent period, steep-grade cable railways in various parts of the globe, but notably in Switzerland and in the Alps generally, where they alone exceed 20 in number, have been constructed for being worked either by component of gravity with water ballast, in conjunction, on some lines, with a second or compensation cable, or in some cases by fixed hydraulic, gas, or steam motors.

The principal disadvantage common to all lines worked by component of gravity consists in the excessive additional dead load due to the water ballast, which entails not only a great deal of additional brake power *per se*, but a variety of complicated safety brakes, involving very careful manipulation; while the three systems of fixed motors are either uneconomical, or unwieldy and obsolete.

The superior advantages of cable traction by electrical motors, as compared with all the other systems referred to, have been attested by three lines in Switzerland, all of which have been constructed within the last four or five years—to wit, the Burgenstock, on the Lake of Lucerne; the Monte Salvatore, on the Lake of Lugano; and the Stanserhorn, near the Lake of Lucerne, which last-named was opened for traffic only last year. It is not the purpose of this paper to give a detailed description of these lines; suffice it to point their salient, and more especially their electrical features.

(*a.*) *Burgenstock.*—The summit level of this line is 2,884 feet above the sea, the total rise being 1,443 feet in a little over 1,000 yards, the minimum grade 32, and the maximum 58 per cent. Electric motive power for working the cable and cars is obtained by high-tension (1,600-volt) transmission from a hydro-electric power station 2·5 miles distant, the output of the two series-coupled direct-current Thury dynamos, driven by a high-pressure turbine, being 40 kilowatts, or 60 H.P. Two corresponding series-coupled motors at the summit of the cable railway drive the cable winding drum through belt, countershaft, and bevel gearing; the total reduction being 700 to 5 revolutions, or 140 to 1, corresponding to the regulation car speed of about three miles per hour. The car speed is regulated from the motor station, and not by the driver, except in case of emergency.

(*b.*) *Monte Salvatore.*—This line has a summit level of 2,900 feet, the rise being 2,000 feet in a length of 1·2 mile, the initial grade at the base 17, and the maximum at the summit 60 per cent. The motor station is situated midway up the incline, and the power is derived by a 2,000-volt transmission from a large hydro-electric 1,500-H.P. power station five miles distant; the output of the Oerlikon (Brown) direct-current generator, driven by a high-pressure turbine, being 60 kilowatts. The corresponding motor on the line drives the cars and cable in precisely the same way as on the preceding line, except that the Salvatore incline is worked in two sections.

(*c.*) *Stanserhorn.*—This line ascends an altitude of no less than 6,200 feet above sea level, and has a total rise of 4,570 feet in a length of 2·5 miles. Worked in three sections, having maximum gradients of 30, 60 and 62 per cent. respectively. The requisite power per car is 40 H.P., and a motor station is placed at the summit of each section. The three Thury motors actuate the

winding drums as before described, and are fed from the same power station as the Burgenstock line, but by a separate high-tension (2,000-volt) transmission 2·5 miles in length. The total efficiency on this, as on the other lines, is about 60 per cent.

(*d.*) *Conclusions.*—The three lines of which I have given a necessarily very incomplete *résumé* mark a conspicuous advance in cable traction. As compared with haulage by the other systems referred to, they show a saving in car weight of no less than 50 per cent., the full car load with 36 passengers being in the former case 12 to 15 tons, and on the electrically worked lines only 6 to 7 tons. Again, the average cost of construction of the Swiss cable railways worked on the older systems is no less than £41,000 per mile, whilst that of the electrical lines is only £24,000 per mile, or 40 per cent. less. Similarly, the working expenses on the older lines vary, with one or two exceptions, between 60 and 80 per cent., whereas the electrical lines are worked at 45 per cent. of the receipts. These three lines also show a remarkable development due to electrical traction *per se*, inasmuch as, apart from the unprecedented grades, up to 62 per cent., or 1 in 1·6, the length of the incline has been gradually increased from 1,000 to 2,200 and 4,500 yards, which, having regard to the mechanical work performed on the grades, is equivalent to 14, 20, and 44 miles respectively on the straight and level. And, lastly, the superior safety and smoothness of electrical working, attested by the Burgenstock and Salvatore lines, has made it possible to dispense on the Stanserhorn incline with the rack used as a safety factor on its two predecessors; so that on Stanserhorn electrical traction has achieved the feat of scaling Alpine altitudes which, it was hitherto believed, could only be reached by rack railways worked with special steam locomotives, such as those used on the neighbouring mountain Pilatus, at more than double the cost per train mile.

Traction by Motor Cars or Locomotives with Fixed Conductors.

The first steep-grade railway worked by electrical traction with fixed conductors in Europe was the Florence and Fiesole line, opened in 1891. It was in succession followed by the Murren mountain railway, in Switzerland, opposite the Jungfrau; by the Mont Salève line, in Savoy (near Geneva); by the Genoa, and then by the Zurich steep-grade road railways; and quite recently by a similar line at Barmen, in Rhenish Prussia.

Of these lines, those of Florence, Murren, Genoa, and Zurich have continuous grades of 8, 5, 7, and 6 per cent. respectively, and are worked as simple adhesion lines, with overhead contact wires, and return circuit by the electrically bonded rails: while the Salève and Barmen lines, having continuous inclines of 25 and 18 per cent., or 1 in 4 and 1 in 6 respectively, are worked with the aid of a rack, and the former has an outside conductor rail in the shape of an inverted ordinary flange rail, while the latter has overhead contact. The Murren line is the only one worked with electrical locomotives; all the others are worked by single motor cars.

(*a.*) At *Florence*, the power station, situated at the foot of the incline, comprises three Tosi boilers, three Oerlikon vertical compound 90 H.P. engines, and three belt-driven Edison bipolar dynamos with a total effective power of 245 H.P., equal to 93 per cent. efficiency. The 12 motor cars are each fitted with two 20 H.P. spring-suspended and series coupled Sprague-Edison motors, the original ones having double reduction, the more recent ones single reduction spur gearing. The contact is by trolley wheel and pole, and the total efficiency of the system is 66 per cent.

(*b.*) On the *Murren* railway, whose altitude is 5,300 feet above sea level, power is generated by a high-pressure turbine, which drives a direct-coupled Oerlikon (Brown) bipolar dynamo of 120 H.P. The power station is situated about midway of the line, the power being derived from the torrent of the celebrated Staubach Fall. The four locomotives weigh 7·5 tons each, and carry two 30 H.P single reduction spur geared motors; the tractive force of each locomotive being about one-third of its weight, and the total efficiency of the system 68 per cent.

(*c.*) The power station of the *Mont Salève* line (summit level, 3,700 feet above the sea) is situated about a mile from the line, and comprises two low-pressure turbines and two separately excited Thury multipolar dynamos mounted on the vertical turbine shafts, and giving, at the low turbine speed, 500 H.P., or only a quarter of their combined normal output of 2,000 H.P. The 12 motor cars are each fitted with two 30-H.P. four-pole Thury motors, with double spur gear reduction, and current is taken from the outside conductor rail by metallic slide contact shoes. Owing chiefly to the unnecessarily heavy gearing, the total efficiency is only about 52 per cent.

(*d.*) At *Genoa*, the power station is about 1·3 mile distant from the line, and contains at present two boilers, two compound condensing Tosi 160-H.P. engines, and two belt-driven 110-kilowatt Siemens inner-pole dynamos. The present line, which is the nucleus of a projected suburban system, is worked by six cars, each fitted with two 16-H.P. Siemens motors; the reduction being 10 to 1, by chain and toothed wheel. Current is taken from the overhead wire by two Siemens & Halske's rectangular metallic contact frames.

(*e.*) The Zurich power station is placed at the upper end of the line, and comprises two boilers, two 100-H.P. Oerlikon vertical engines and dynamos, together with an accumulator battery of 300 Tudor cells for compensating the variations of load of the steam engine. The 12 motor cars are each fitted with two 12-H.P. Oerlikon motors. The total efficiency of the line is 65 per cent.

(*f.*) At Barmen, the power station is situated at the foot of the incline, and contains two 225-H.P. compound condensing engines driving direct two Siemens inner-pole ring dynamos, whose output is 155 kilowatts each. The line is worked by 10 motor cars, each provided with two 36-H.P. Siemens motors, which, by single spur gearing actuate the rack pinions mounted direct on the car axles. The total efficiency is, like that of the other lines, from 60 to 65 per cent.

(*g.*) *Conclusions.*—It is seen that the primary generating power is steam on the Florence, Genoa, Zurich, and Barmen, and hydraulic on the Murren and Mont Salève lines; the dynamos being direct-driven in four, and indirect in the other two cases. Notwithstanding the high cost of fuel in Italy and Switzerland (as much as 30s. per ton), and the steep grades on the Florence, Genoa, and Zurich lines, the running expenses do not exceed 4·5 pence per car mile; while the total working expenses, including administration and renewals, are within 7·5 pence per car mile, or about 50 per cent. of the receipts. On the Murren and Salève lines, the cost of hydraulic power per annum is, of course, restricted only to wages and repairs. In the former case, the working expenses do not exceed 40 per cent. of the receipts; while in the latter they are as much as 80 per cent., this high rate being due chiefly to inadequate fares. A specially noteworthy feature is the steady speed of 8 to 10 miles per hour with which motor cars run up the steep adhesion inclines of 6, 7, and 8 per cent. at Zurich, Genoa, and Florence; while on the descent a speed of even 15 miles per hour has proved perfectly safe, in conjunction with the powerful and instantaneous action of the electric safety brake constituted by the motors acting as dynamos on the descent, although, for all ordinary purposes, even the mechanical brake alone suffices to stop the car within its own length.

As regards the comparative working cost of steep-grade adhesion or rack railways by steam and by electricity, I can affirm from my own experience, as well as from every other case which I have had occasion to investigate, that, irrespective of the immensely greater elasticity of the service, and consequently the far more rapid development of the traffic, electrical working ensures an economy of at least 50 per cent. as compared with steam.

General Conclusions.

With regard to electrical traction on flat, as well as steep-grade lines generally, I am led to the following conclusions:—

Direct and Indirect Driving of Generators.—Although direct driving, whether by steam engines or by turbines, is the ideal standard, and, therefore, always preferable, it cannot, for tractive purposes, be laid down as a dictum *à priori*. On lines having steep, and more especially alternately rising and falling grades coinciding with sharp curves, an intermittent traffic, and frequent stoppages, the variations of load are so great and so rapid—often from zero to maximum in the space of one minute—that vertical high-speed engines suitable for direct driving generally work very uneconomically. This is, *e.g.*, the case at Florence, and in an even greater degree at Marseilles, where high-speed direct-driving engines had actually to be replaced by horizontal low-speed Corliss engines, with belt driving. In the case of hydraulic power, high-pressure turbines always admit of economical direct driving, whereas low pressure turbines involve for direct driving proportionately larger dynamos, giving only part of their normal output, so that here, too, indirect driving by gearing or belt is generally more economical. The same applies where gas engines are used.

Steam, Hydraulic, and Gas Generating Power.—The first cost of an hydro-electric installation often exceeds that of steam plant, more especially in the case of a variable volume and small head of water, involving the use of low-pressure turbines. High-pressure turbine installations are always preferable and more economical. Where cheap hydraulic power is not available within a distance of about four miles from the line, and fuel is dear, gas manufactured on the spot is much more economical than steam power.

Conductivity of Rails.—Where the rails serve as the return circuit, the ordinary fish-plates should have the same sectional area as the rails, so that, together with stout fastenings, they make a joint as stiff as the rail itself. In this way, and especially when laid on metallic sleepers, the permanent way gives 80 per cent. of the required conductivity at the joints; so that only 20 per cent. has to be made up by copper bonding, *plus* an adequate margin of, say, 10 per cent. Solidity, compactness, and careful maintenance of permanent way, as is usually found on electrical lines, as well as on railways generally in Europe, go far to make up for the elaborate copper bonding which the often defective condition of permanent way necessitates on American lines. It is for the same reason that electrolytic action on gas and water pipes, which is so common a phenomenon in the States, is practically unknown in Europe.

Conductor Rail.—Where a conductor rail is used, it should preferably be placed outside, instead of inside the ordinary rails, because the outside conductor obviates all complications, and the contingency of short-circuit at points and crossings. On specially steep grades, involving the use of a central rack, the rack rail or bar itself, having continuous contact with the pinion wheels, constitutes an excellent conductor, provided it be effectually insulated from the sleepers by porcelain bells serving as supports.

Overhead Trolley Wheel and Slide Contact.—Contact by a trolley wheel whose spindle is rigidly held by the trolley pole is suitable for lines on which straight sections and flat curves predominate; but for lines with numerous and sharp curves, the rectangular single or double slide-contact frame, as used by Messrs. Siemens & Halske on their overhead lines, is far preferable. It is lighter and more pleasing in appearance than either the rigid trolley, the flexible South Staffordshire trolley, or the slide-contact bars used on the Isle of Man line. It obviates, moreover, many of the objectionable cross and diagonal wires, and hence the infinite variety and complexity of fastenings which the use of the rigid trolley wheel involves, and many of which, however neat as mechanical contrivances *per se*, are not exactly ornamental objects when suspended at a height of only 20 feet above the roadway. The only defect to which the Siemens slide contact is subject consists in the upper, slightly arched, and, of course, renewable contact side of the frame being liable to become grooved, whereby the easy play to right and left of the contact wire is impaired; but this defect can be easily remedied by employing

material of adequate resistance. Another and very simple form of slide contact is that used on an electric road railway from the Lake of Lucerne to the foot of Stanserhorn, and consisting in a crescent-shaped grooved contact piece of bronze, which is loosely hinged to the trolley pole, and thus, in conjunction with the lateral play of the pole, adjusts itself to the sinuosities of the line.

Underground Contact and Accumulator Cars.—It is generally recognised that the overhead trolley system, which, in reality, is only a makeshift, is unsuited for the central parts of the large towns, and *a fortiori* of the metropolis of this country; and the same applies equally to the other largest capitals of Europe—to wit, Paris, Berlin, and Vienna. In these cases, the conduit system or accumulator cars are therefore, at present, the only practical solution of the problem. In Europe, the conduit system, whether it be that of Buda-Pesth, or with a central slot, may be estimated to cost, complete, £10,000 per mile and upwards, according to local conditions, though this is not too costly, having regard to the enormous traffic in large towns; but its efficient working presupposes, among other things, very perfect drainage of the trench. As regards accumulator cars, they would really constitute an ideal form of electrical tramway traction, if the present car-weight of 12 to 15 tons, and the power and traction expenses of 8d. to 10d. per car mile, could be reduced to half. As a case in point may be quoted the unwieldy accumulator cars which run on the Madeleine and St. Denis Tramway in Paris, and give fairly satisfactory results, but which, owing to their heavy weight, are not infrequently deficient in torque on the long 1 in 20 grades, when the motors become saturated. The overhead system, on the other hand, is very well adapted for suburban tramways, and eminently so for light railways and road railways in the country. The cost of such road railways, if constructed on the metre, or 3-feet 3-inches gauge, can well be kept within £6,000 per mile, including electrical equipment; and the already quoted road railway from the Lake of Lucerne to the foot of Stanserhorn, which only cost £4,500 per mile, as well as another similar line near Bâle, have demonstrated what a cheap and convenient motor car service can do in essentially agricultural districts.

Gearless and Geared Motors.—Gearless motors are eminently suitable for high speeds, while for low speeds they require to be of inconveniently large size. For geared motors single reduction is, of course, always preferable, although on exceptionally steep grades, where the motors have to develop their maximum power at a minimum car speed, double reduction may in some cases be unavoidable. In any case, spur gearing is always preferable to worm gearing or chain motion, both of which involve too much friction and consequent loss of power.

Parallel and Series Coupling of Motors.—This much-debated question cannot be decided *à priori*, but depends on individual cases. For level or easy-grade lines, parallel coupling is more suitable; whereas on steep grades, where starting requires always the maximum torque, series coupling is generally called for.

Variations of Load.—On lines with steep or rising and falling grades, these variations cannot be mitigated, much less equalised, simply by increasing the number of cars or trains on the line, since the variations are caused not only by the varying traffic, but by the varying grades and curves, and by the varying degrees of adhesion, more especially in starting. Where separately excited dynamos are used, a partial means of compensating the variations of load is, as is well known, that of varying the excitation by the main current passing through the exciter. But the most effectual remedy is the addition of an accumulator battery, which absorbs any excess of supply from the generator over demand on the line, and, *vice versâ*, makes up for any deficiency of supply, so that the steam engine and generator can always run at full and constant load. Accumulator batteries have fully vindicated their claim as an important auxiliary and as a means of economical working of traction installations at Zurich, and subsequently in the Isle of Man, and well repay the additional first cost of plant.

Continuous and Alternate Current.—Hitherto continuous current has been exclusively used for electrical traction. But, having regard to the high degree of efficiency and perfection and the ease of starting recently attained in alternate current motors, thanks notably to the persevering efforts of such constructors as Messrs. Brown, Boveri, & Co., it may be confidently predicted that, as in lighting installations and in power transmissions for industrial purposes, so also in electrical traction alternate is destined to supplant continuous current. Alternate current, whether single or multiphase, will not only admit of electrical traction being applied over much longer distances than is economically possible with continuous current, but it will ensure a saving of something like 30 per cent. in the weight of the dynamos and motors, irrespective of the saving in copper of feed and contact wires, and will thus considerably simplify and cheapen electrical installation and equipment for tractive purposes. But, whether by alternate or by direct current, on flat as on steep grade lines, on so-called light railways as on tram-roads in town and country, we may be well assured that electrical traction in its various forms has, both in this United Kingdom and throughout Europe, a brilliant and triumphant future.

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*Dr. N. S. Keith opened the discussion. He said he could add, for whatever interest it might be to the Institution, a short description of a plant in California, in which a grade was ascended of 1,600 feet in 3,000 feet by means of electrical power. This was the Pasadena and Mount Wilson railroad, in the southern portion of California. The line ran from Pasadena, and would eventually end on the top of Mount Wilson, some 13 to 15 miles away, at an elevation above the sea of 7,000 feet. The line was completed a year ago last July to the top of Echo Mountain, 3,500 feet above the city of Pasadena, which was some few hundred feet above the sea level. For a distance of four or five miles the grade was a very uniform one of about 7½ per cent. It then went up to a grade which necessitated an ascent, as far as he remembered, of 1,600 feet in 3,000 feet. This ascent was made by a cable run by a 75-H.P. Keith electric motor, placed on the summit of the rise. There were two cars fixed upon it at equal distances on the cable, so that when one ran up the other ran down, and they thus balanced. The cars were so constructed that the seats were upon a level, or ran horizontally; the inclination was one of 45°. The motive power was a 75-H.P. motor, receiving its current from two sources. At a small town half way between this severe rise and the town of Pasadena were located two 60-H.P. gas engines. At various localities in the mountains above were placed dynamos driven by Pelton water-wheels, very small quantities of water having a great pressure playing tangentially against a radial box upon wheels. This was a necessity, because the quantity of water available for water-power was insufficient. It was contemplated, and would be carried out by the time the line was completed to the top of Mount Wilson, to derive a quantity of water from the other side of the mountain; 400 feet below the summit of the mountain there was a small stream flowing. It was in contemplation to pump this water for 400 feet by electrical power, allowing it to fall on the western slope of the mountain, where it had a descent of 7,000 feet. Two or three hundred feet in excess of the 400 would ensure the production of sufficient power to run the pump and motor, leaving, then, some 4,200 or 4,300 feet fall for power purposes.

Mr. Mark Robinson said he wished to say a few words on the commercial aspect of the papers. Like many others, part, at least, of his living was bound up with the development of electrical industries in this country, and he believed that these papers came at a most opportune time, and gave no small help to the development of those industries. Electric traction was certainly going to be a matter of magnitude very few of them were able to gauge, to the great benefit of engineers and electricians as well as to those capitalists who built the lines, and the public who would use them and profit at least as much. Not forgetting the good work done in Germany and other Continental countries, and the really remarkable traction works in England, which, unfortunately, were limited in extent, he thought they would all allow that the country which could teach them most in electric traction was America. In the last session they had the general progress of electricity in America sketched for them by the master hand of Mr. Preece; now they had the hand of a younger electrician, who had utilised his stay in that country to report the progress in one particular direction. It should be very gratifying to them that not only did their American friends lay their experience and knowledge open to Mr. Wilkinson as an individual, but also avowedly placed them at his service for the purpose of laying the results before this Institution. Then they had an American engineer coming to them and laying before them fully, and, as far as he (the speaker) could judge, without any reservation at all, not the general facts of car traction, but those important details upon which success depends, the "how to do it" and the "how not to do it," which they wanted to learn. Mr. Blackwell's and Mr. Dawson's paper struck him as being very restrained and very free from self-seeking. Their display of apparatus seemed to his colleague and himself so interesting, that, having friends in France at present engaged on a large traction scheme, they thought they could do them no better turn than to ask them to come over and be present at that meeting and see that collection of apparatus. Although those gentlemen, owing to the curse of Babel, were not able to join in the discussion, they said they were rewarded for coming over by the inspection of those very interesting apparatus. As one of those who confidently expected very great advantage from the certainly imminent development of electric traction on a great scale, he begged to tender his thanks to the authors. Dr. Preller's paper dealt specially with mountain railways, for which there was no great scope in this country, and they must all feel that the papers on American practice came most closely home to them. If anything would tempt him to indulge in criticism or to trespass upon the province of the expert, it would be some of the statements in Dr. Preller's paper, certainly one with regard to high speed engines for electric tramway work; but he would not touch upon that now, for that discussion, to be of any use, ought to have taken place several years ago.

Mr. H. F. Parshall said he had listened to the papers on American tramways with unusual interest, primarily, because he had designed a great amount of the apparatus that was at present used in the United States; and, secondarily, because he was always desirous of finding out whether British engineers had noticed anything peculiar to American tramways, as very frequently they did notice things peculiar to their various other institutions. He should not attempt to discuss the papers separately, but inasmuch as they covered in considerable extent, practically, the same ground, he should take the points in either one or other, or both of them. Perhaps one of the most important points was with respect to the earth returns. As was commonly known, they were experiencing a great deal of difficulty in the United States. He might say, as a result of rather a close study of the troubles there, that they might have been avoided at the start if the engineers had carried out the works upon the principles which were thoroughly well understood, and not difficult to follow, as they knew the connection between the rails was made by bonds and pressure contacts. Now, they had had quite a definite experience with pressure contacts in their central station practice. They knew the folly of having copper surfaces brought into the most intimate relations and at comparatively high pressures—about 300 ampères per square inch was the highest they could work on, even when there was an entire absence of oxidisation. Underground they had the contact between copper and iron, and seeing that in a central station they did not go over 50 ampères per square inch, he did not know why they should expect to do so in the case of tramways, where in many cases there was not less than

* Those marked with an asterisk have been revised by the authors.

1,000 ampères per square inch. This was an immediate source of trouble. The matter could be entirely eliminated by simply proportioning the section of the contact between the rail and the bond to suit the current that was to be carried. If they had 1,000 ampères per square inch as the mean value in the bond, then the contact between the rail and the bond should be 20 times the cross-section. For the larger stations such as they were installing in Brooklyn, where the current output was 12,000 or 15,000 ampères on the average, and 600 volts, the amount of contact surface became enormous. This trouble they were overcoming very largely by electric welding. They put in a sort of auxiliary plate and electrically welded it to the rails. With this, so far as had been ascertained, there had been no trouble. In fact, he was inclined to recommend an electrically welded underground system everywhere where it could be afforded. The next point he thought English engineers would be interested to know about was the amount of power taken by an ordinary car under what might be considered average working conditions. He could state as the result of a great many experiments, that the amount of power under approximately the same conditions, varied directly with the number of stops; but under ordinary frequency of stopping, it was one Board of Trade unit per car mile, which was usually regarded as a fair value. A further interesting fact with regard to the amount of power was that the watts per car mile remained approximately constant over a wide range of speed. From this they could draw the interesting conclusion that the watt output of a station was proportional to the number of car miles. With the series parallel method of control the force for starting a car was about 60 lbs. at the periphery of the car wheel per ampère. With 50 ampères, or a force exerted at the motor corresponding to 3,000 lbs. at the car wheel under ordinary conditions, the car would accelerate at the rate of 2 feet per second. This was, he thought, quite as fast as was desirable, especially with people on the tops of cars, corresponding to the people standing up in American cars. With the series parallel motor, where the stops were frequent, there was a decided economy in having two motors per car. Where the stops became infrequent, say at every half mile, then the single motor, with rheostat control, compared favourably in efficiency with the two motors in series parallel control. The statement he had made that the number of watts per car mile remains constant through a considerable range of speed in the best design of motors diminishes somewhat in speed. Speaking of speed, he was reminded of the somewhat stringent rules that obtained in England on that matter, and he might say that their practice in the States was roughly that, in the crowded thoroughfares, the car speed was about three or four miles an hour, and in the least crowded thoroughfares, the suburban streets, as high as 20 miles an hour; but the number of people killed, as most always happened, was inversely as the car speed. That was to say, they killed the people on the crowded streets, where the cars were moving slowly. He should like to point out first with regard to this slow speed, that it necessarily increased their investment in cars and motors 50 per cent. for a corresponding number of car miles in the States. As a secondary point, the application of electric traction was limited—that was to say, its usefulness was limited—on account of the rule in regard to the outlying districts; it simply lessened the efficiency of the whole thing as an investment to the extent of 25 or 30 per cent. Still, as the statistics they had gathered from the roads in Great Britain showed, there was a satisfactory margin left, and the only point was whether or not engineers should not be able to demonstrate to the satisfaction of the Board of Trade that they might safely drive their cars faster in the less crowded thoroughfares. A point once more brought up in the paper read that night was with respect to the application of alternating currents to street car motors. He was perfectly familiar with the work done on both sides of the Atlantic in the development of alternating currents, and he knew of the work accomplished by Mr. Brown, but he did not see that it left any hope for expecting the adoption of polyphase motors for car traction. The three-phase motor was the only one that approximated to their requirements, and as that had less torque than the series parallel control it was out of the question; it required approximately equal inductance and resistance in all the branches. In other words, it wanted a resistance of the earth circuit, which he imagined was rather beyond the engineering of the present day. His next point was with respect to direct connected generators, and their experience with them in the United States. At the World's Fair they made their first grand exhibition from their standpoint with 750 and 1,500 kilowatt direct connected machines. They were to operate the intra-mural road, in which there were 14 trains, 67 tons per train. The average power taken per train was 42 kilowatts, but the maximum frequently exceeded 300 kilowatts. It was found rather more economical to operate a road of this size with a 750 kilowatt machine. He had at hand the report of the chief engineer in charge of the road, and also the speed and current curves taken, and would be glad to show them to members. An interesting point brought out was that the managing director of the road complained to the engineer in charge of the interruption of service caused by the opening of circuit-breakers. The man, with characteristic Yankee ingenuity, or the lack of it, simply plugged the circuit-breaker, and his statement to the speaker was that when the crowbar was placed across the earth return, it either rolled off or was burnt off. The strain on the engine was most severe. The engines were taken down at the end of the Exposition, and were found to be in perfectly good condition, so that he judged the mechanical stress brought upon this class of apparatus had no serious influence on the durability of the engine. He might state in conclusion, with reference to the future practice in the United States, and, he hoped, in England, that great fluctuations in power should be avoided. By carefully studying the point, he thought engineers could avoid it. There would be a direct advantage in every respect. The principal one would be the decided gain in economy. The smaller steam engines could be used, and engines worked under average conditions at their most economical horse-power. This was what they were striving to do in the States at the present time, but he did not think they were as successful in accomplishing it as were engineers in Great Britain, with their more carefully ordered way of proceeding about engineering matters.

(To be continued.)

Physical Society of London.

Ordinary General Meeting, November 23rd, 1894.

Prof. Rucker, F.R.S., President, in the chair.

Mr. Womack read a paper on A Modification of the Ballistic Galvanometer Method of Determining the Electro-Magnetic Capacity of a Condenser.

The condenser is placed in parallel with one arm, s, of a Wheatstone bridge arrangement of non-inductive resistances. A balance for steady currents having been obtained, the condenser is placed in circuit, and the throw on depressing the battery key determined. The condenser is then thrown out of circuit, and the proportionality of the arms of the bridge disturbed by changing the value of s to $s + d s$. The steady deflection due to this change is then read. From these two readings and the known values of s and $d s$, the capacity is immediately determined. In practice, readings of deflection may be taken with equal positive and negative values of $d s$. To avoid changes of E.M.F. of the battery, the author finds it best to a use a reversing key in the battery circuit, and to observe the throw on reversing the current instead of on simply breaking it. One advantage of the method is, that there is no need to know the galvanometer—or battery—resistance, and the author points out that it may be of service in the simultaneous determination of the resistance, and of the joint capacity and inductance of a submarine cable, or of a telephone or telegraph line.

Prof. Perry asked what were the advantages of the method as compared with the Rayleigh-Sumpner method.

Mr. Blakesley thought that the correction for damping in the ballistic part of the experiment might be avoided, if in the second part the disturbance of balance, due to the increment, $d s$, were measured by half the first throw of the needle on making the galvanometer circuit instead of by the steady deflection. He doubted whether reversing the current in the battery circuit would have just twice the effect of simply breaking the circuit.

In reply, Mr. Womack said he had not tried the method of reading suggested by Mr. Blakesley, but with regard to the reversing of the battery circuit, that was found to give, in practice, as nearly as possible twice the deflection which resulted from simply breaking.

A paper by Prof. S. P. Thompson and Mr. Miles Walker, on Mirrors of Magnetism, was read by Prof. Thompson.

It was pointed out that corresponding to the theory of electric images produced by insulated conductors, there is a theory of magnetic images produced by bodies of infinite magnetic permeability. A magnet pole in the latter theory is the analogue of an electric charge in the former, and a body of infinite magnetic permeability is the analogue of an insulated conductor (which is electrostatically indistinguishable from a body of infinite dielectric capacity). Experiments were made to determine how far the magnetic images due to thick sheets of iron accorded with those deduced by theory for the case of infinite permeability. The image of a north pole in an infinite plane sheet should consist of a south pole of the same strength at a point coinciding with the optical image of the north pole, together with an equal north pole distributed uniformly over the surface of the infinite sheet, as a free electrical charge would be, and so exerting no finite action. Working at distances of a few inches in front of the surface, a sheet of iron a few feet in length and breadth, and a couple of inches thick, was found to realise the theoretical conditions with very tolerable exactness. In a coil of wire placed on one side of the sheet, a current was started or stopped, and the electromotive impulse produced in a subsidiary exploring coil was detected by means of a ballistic galvanometer. That the effect of the actual mirror was equivalent to that of the theoretical image was verified by substituting for the iron a coil equal and similar to the first, and coinciding with its optical image. Sending the same primary current, as before, round the two coils (with due regard to its direction in the second coil), hardly any appreciable difference in the secondary impulse was observed. This was found to hold good whether the original primary coil had its axis perpendicular or oblique to the plane of the magnetic mirror. Some observations on spherical sheets were also recorded, but in this case the conclusions were less simple.

The paper was followed by a discussion in which Mr. Boys, Prof. Perry, Prof. Ayrton, Dr. Burton, Mr. W. Bailey, and Prof. Carey Foster took part.

Prof. Ayrton exhibited a Student's Apparatus for Verifying Ohm's Law, designed by himself and Mr. Mather.

The current flowing through a circuit is to be measured (not necessarily in terms of any defined unit) by means of a galvanometer, while the potential-difference betwen two fixed points is measured by means of an idiostatic electrometer. Within small limits of experimental error, the current and potential difference are found to vary in the same proportion; but the electrometer and its manner of use constituted the chief interest of the paper. The fixed and moving parts (inductors and needle) are alike cylindrical in form (the term being understood in its most unrestricted sense) and the generating lines are vertical. There is a vertical axis of symmetry, such that the disposition of these cylindrical parts would remain unchanged if the instrument were rotated through 180 degrees

about the axis. The needle is hung by a very thin phosphor-bronze strip, and to obtain a reading when it differs in potential from the inductors by an amount which we have to measure, it is brought back to its ordinary zero position by turning a torsion-head to which the upper end of the suspending strip is fixed. The potential-difference is then proportional to the square root of the angle through which the torsion-head has been turned; but the E.M.F. of a moderate battery of accumulators can be read with very fair accuracy. The authors have bestowed great care on the design of the needle, so that for a given potential difference the turning moment divided by the moment of inertia may be as great as possible. The whole instrument is protected from external inductive influence by having the inner surface of its glass case coated with a transparent conducting varnish, which Prof. Ayrton has described elsewhere.

Prof. AYRTON also showed an IDIOSTATIC ELECTROMETER, whose needle, instead of being suspended, was pivoted on an axle. The instrument is rapid and nearly dead-beat in action, and gives a scale-reading of about 3 inches for an E.M.F. of 100 volts.

Prof. S. P. THOMPSON expressed great admiration for the instruments exhibited, but denied that the law which they served to prove was Ohm's law at all; and this led to some discussion as to what Ohm's law really is.

Prof. AYRTON briefly replied.

NEW PATENTS—1894.

21,782. "Improvements in automatic electrical rheostats." T. CAINK. Dated November 12th.

21,814. "Improvements in electric arc lamps." J. TORGE. Dated November 12th.

21,821. "Improvements in two-pole single-limb dynamo-electric machines and electro-motors having vertical magnets with the poles downwards." T. PARKER, LIMITED, and T. PARKER. Dated November 12th.

21,822. "A vessel for the electrolytic separation and alloying of metals in the molten state." J. C. MEWBURN. (Communicated by The firm of F. Hornig and W. Borchers, Germany.) Dated November 12th.

21,827. "A method and apparatus for exciting dynamo-electric generators." J. IMRAY. (Communicated by La Société Anonyme pour la transmission de la force par L'électricité, France.) Dated November 12th.

21,838. "New or improved process for electrolysing chemical combinations and winning the products of decomposition formed by the electrolysis." W. BEIN. Dated November 12th. (*Complete.*)

21,845. "Improvements in dry batteries." R. MYERS. Dated November 12th.

21,855. "Improvements in tools or appliances for use in the trueing up, scouring, or like treatments of dynamo-electric machine cylinders and the like." W. P. ADAMS and R. E. B. CROMPTON. Dated November 13th.

21,879. "Improved methods of effecting the electro-fusion of metals and in apparatus therefor." B. H. THWAITE and H. ALLEN. Dated November 13th.

21,893. "Improvements in autographic telegraphs." J. O'NEIL. Dated November 13th. (*Complete.*)

21,929. "Improvements in electric-current regulators." H. V. KEESON. Dated November 13th.

21,948. "Improvements in holders for incandescent electric lamps." J. Y. JOHNSON. (Communicated by A. Swan, United States.) Dated November 13th.

21,991. "Improvements in or connected with electric tramways and vehicles." H. EDMUNDS. Dated November 14th.

22,029. "Improvements in electrically propelled fans." J. H. PICKUP and J. H. HINDLE. Dated November 14th.

22,030. "Improvements in or connected with electrically propelled carriages for common roads." F. KING. Dated November 14th.

22,040. "A new combination switch with safety fuse attachment." D. F. ADAMSON. Dated November 14th.

22,043. "Improvements in means to be employed in connection with the electrical heating of metals for various operations." W. HOLLAND, Jun. Dated November 15th.

22,046. "Improvements in arc lamps." F. M. LEWIS. Dated November 15th.

22,070. "An improved process and apparatus for the electrolytic decomposition of metallic salts, and for treating products therefrom." J. HARGREAVES and T. BIRD. Dated November 15th.

22,119. "An improved method of connecting electrically the rails of tram or rail ways." F. F. ROBINSON. Dated November 15th.

22,134. "Improvements in the electrical propulsion of boats and vessels." A. G. NEW and A. J. MAYNE. Dated November 15th.

22,157. "Improvements in electrical switches." W. MCGEOCH, Jun. Dated November 16th.

22,192. "An electric exploder." SIEMENS BROS. & CO., LIMITED, and A. S. SCHLOEMER. Dated November 16th. (*Complete.*)

22,197. "Improvements in recording telegraphic apparatus." A. DAMASKINOS. Dated November 16th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

19,251. "An electric indicator for use in colliery engine houses and railway signal cabins." C. B. CRAWSHAW and J. BATTYE. Dated October 13th. A signal is given from any point by touching a small press-button or plunger which is connected to a magnet by an electric-wire; this moves an armature striking a bell or gong, which is supported by a pillar, and also moving a connecting rod which may be fixed either to the top or the bottom of the armature. The rod being thus moved causes a catch to draw backwards one tooth of a ratchet wheel. This ratchet wheel being attached to a spindle, which is fitted into a hole bored through the gong-pillar, turns an indicating hand from zero "0" to fig. "1" on a dial, and each time the signal is given by pressing the before-mentioned press-button, the above process is repeated.

20,384. "Improvements in electricity meters." G. HOOKHAM. Dated October 28th. Relates to improvements in the details of the meter for alternating currents described in complete specification No. 13,123—1890. 6 claims.

20,847. "Improvements in carbon brushes, blocks, or collectors for electric generators and motors." W. H. SCOTT. Dated November 3rd. Consists in making each carbon brush or collector of a small rectangular or round block of carbon with a hole through its centre. This carbon block is fastened on to a light rod tube or wire which is connected to the brush holder by means of springs or the like in such a way that it can be made to press the carbon block on to the commutator. The carbon block is fixed between two collars in a suitable position on the rod, tube, or wire. One of these collars is removable so that the carbon block can easily be replaced. 2 claims.

20,975. "Improvements in voltaic batteries." J. A. S. GREGG. Dated November 4th. Relates to an automatic system for the renovation and discharge of the electrolytic liquid in voltaic batteries according to the requirements of the work being done by the battery or cell, and is to be used principally in connection with electrolytes, the specific gravity of which decreases as the process of electrolysis progresses. 9 claims.

22,856. "Improvements in or connected with printing telegraphs." R. A. FOWDEN. Dated November 28th. In a printing telegraph system embodying features of the invention, use is made of instruments connected together by a single line conductor and provided with duplicate mechanical and electrical devices operated synchronously by means of two sets of local circuits and switches, whereof one set is employed for transmitting and the other in receiving, and by means of two line circuits, of which one is availed of for releasing and starting the type-wheel shafts, and the other for effecting the printing operations, and both of the said line circuits traversing the single line conductor. 106 claims.

23,477. "Improvements in contacts for electrical signalling on railways." J. ORME. Dated December 6th. Consists in so attaching a metallic brush to the train that it is capable of moving backward and forward upon a pivot, whereby a double purpose is served, viz., to utilise the movements to actuate a local bell, either electrical or mechanical, and also the movements permit the brush to rise over any obstruction that it may encounter. 3 claims.

23,478. "Improvements relating to the electrolytic preparation of oxygen and the halogens, and to the simultaneous production of electrodes." A. COEHN. Dated December 6th. Claims :—1. The improved process for the electrolytic production of oxygen and the halogens, characterised by the employment of a cathode capable of taking up hydrogen, which cathode may be formed of metal, so that the electrode thus produced can be afterwards employed in the generation of current in primary or secondary batteries. 2. An electrode produced in the manner substantially as described and for the purposes specified.

24,083. "Improvements in percussion drills and other percussion tools worked by a rapidly rotating motor." SIEMENS BROS. & CO., LTD. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated December 14th. Consists in the use on the driving shaft of the percussion apparatus of a fly-wheel which is driven by a quick-speed motor through the medium of a flexible or jointed transmission shaft and suitable speed reducing gearing, the energy thus stored in the fly-wheel being expended in imparting the percussion motion to the tool. 2 claims.

24,084. "Safety feed apparatus for rotary drills and similar rotary working machines." SIEMENS BROS. & CO., LTD. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated December 14th. Relates to an improved automatic feed mechanism whereby the feed is capable of automatic regulation in so perfect, simple, and reliable a manner as to render the effectiveness of the drilling operation entirely independent of the attention or skill of the operator. 2 claims.

1894.

5,807. "A duplex electrical safety fuse." THE EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LTD, and C. F. PROCTOR. Dated March 20th. Claim:—A duplex electric safety fuse constructed substantially as described with reference to the drawings.

5,989. "Improved method of and appliances for manipulating search light projectors." W. ELWORTHY. Dated March 22nd. Has for its object the elevation, depression and turning of the projector from the bridge, or other suitable part of the vessel by means of electric motors, without requiring an attendant at the projector itself. 4 claims.